EFFECTS OF COOPERATIVE LEARNING STRATEGY ON STUDENTS' ACHIEVEMENT IN BASIC SCIENCE IN RIVERS STATE

BY

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DELTA STATE UNIVERSITY
ABRAKA

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CERTIFICATION

We certify that this thesis was written by Egwanwor, Williams Ifeanyi Joel in the Department of Curriculum and Integrated Science, Faculty of Education, Delta State University, Abraka.

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DECLARATION

I wish to attest that this is an original work carried out by me in the Department of Curriculum and Integrated Science, Faculty of Education, Delta State University, Abraka.

Egwanwor, Williams Ifeanyi Joel

DEDICATION

This research work is dedicated

to:

the late Chief Joel N. Egwanwor

Maa Gold Wugo Egwanwor

Godsproof C. Egwanwor

Mgbechika PraiseGod Egwanwor.

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ABSTRACT

This study investigated the effects of cooperative learning strategy on students' achievement in basic science in Rivers State. It also investigated the moderating effects of gender and ability on students' achievement in basic science. The purpose of this study is to determine if cooperative learning method when used for instruction could influence students' achievement in basic science; to determine how the intervening variables such as gender and ability affect students' achievement in basic science in a cooperative learning classroom; to determine if there is any difference in achievement between the students exposed to the cooperative strategy and those taught with the lecture method; to determine the difference between the achievements of male and female students exposed to the cooperative learning strategy; to determine if there is difference in achievement among the varying ability students with respect to the different methods of instruction. Nine research questions and nine null research hypotheses were formulated and tested at 0.05 level of significance. A 2x2x2 non-randomized pretest, post-test control group quasi-experimental design was adopted, this consisted of two instructional methods of cooperative learning strategy and lecture method, gender at two levels of male and female, and varying abilities at two levels of high and low. The population for the study consisted of all 259 government-owned (UBE-9) secondary schools in Rivers state with a population of 35,251 students. Six hundred and seven students from six junior secondary schools selected by simple balloting technique from the three senatorial districts in Rivers State were involved in the study. The descriptive and inferential statistics were used to analyze the data collected for the study; and these include the mean, standard deviation, analysis of covariance (ANCOVA). The results showed that there was significant difference in students' achievement between the students exposed to cooperative learning strategy and those taught with lecture method. However, the effect of gender and ability were not

significant on students' achievement for students exposed to cooperative learning strategy; but there were significant effect of gender and ability on students' achievement among the students taught with lecture method. The varying ability students of the cooperative learning group performed significantly better than their varying ability counterpart in control group (lecture method). Based on these findings, it was recommended that cooperative learning strategy be adopted in the Nigerian secondary schools. As a result of the findings of this study it is recommended that, basic science and science teachers in general should expose the students to cooperative method to encourage social interaction among learners. Also, workshops should be organized for science teachers to emphasis the use of cooperative learning.

CHAPTER ONE

INTRODUCTION

Background to the Study

The role of science in the development of a nation is never disputed. This is because; according to Jegede (1983), the current development in science and technology has so greatly affected human beings that to be ignorant of these development is to live an empty, meaningless and probably unrealistic life. Greenbury and Mallow (1982), cited in Inyang and Ekpenyong (2000), contend that a nation with a scientifically uneducated citizenry cannot be expected to make any reasonable technically based

political decision on such issues as nuclear energy and atmospheric pollution because of lack of rudimentary tools to grasp the various arguments.

Olaniyi (1985) opined that in Nigeria, science education is facing a serious problem because of the dwindling number of Nigerian youths both at secondary and post-secondary education levels willing to make science study their major pre-occupation, adding that the academic performance of students in secondary school in recent years has been very poor. This is in line with Igwue (1990) who observed that this poor performance may be due to approaches used by science teachers in teaching science. The predominant use of the chalk-and-talk approach by most science teachers may have contributed to the poor performance of students in the sciences. The abstract nature cannot be resolved through the chalk and talk method adopted by most teachers, but could be brought to reality by grouping students and using cooperative learning strategies.

The involvement of students in group-activities has been suggested by educators, Grambs and Carr, (1979) Sharan, (1980) Webbs, (1980) Peterson, Janichi and Swing, (1981) Ekpo, (1992). One of the issues often debated is that the grouping of students should be by mixed abilities. In this regard, Salau (1995) warned that as long as science is taught by whatever method to a large

group of heterogeneous students in terms of ability, and if individual attention and a corresponding focus on analysis of individual student's problems are not actualized, the problem of poor performance will remain.

Science is taught at the Junior Secondary school level as basic science. It is a basic and compulsory science subject that will enable pupils to acquire knowledge in science and develop skills and attitudes required for scientific and technological advancement in future life (Agboghoroma, 2005).

Science and technology are important tools in national growth and development yet Nigeria has not improved science teaching and learning. One of the reasons for this act is that of non-challant attitude of the Government towards effective teaching and learning of science in schools Kinaka, (2001).

This poor attitude of government towards the teaching of science in schools can be seen from the poor state of infrastructure for teaching and learning of science in schools. Basic science being a science subject suffers the same fate as Chemistry, Physics and Biology. The poor state of infrastructure for teaching and learning basic science has also influenced the method adopted for teaching the subject. Personal observations and a study conducted by Ajaja (2002) indicated that the dominant approach for teaching basic science in schools is the

lecture method. This approach has not improved students' achievement in the subject. This is in line with the performance report of Ale (2008) from students' final year JS III integrated science result as follows: 2003-40%; 2004- 35%; 2005- 50%; 2006 -55%; 2007 -45%; and 2008 -40%.

According to Salau (1999), the method of teaching could be regarded as the vehicle through which a message is delivered. There exist several types of such conventional methods of instruction which have permeated our educational system over the years. Among such conventional methods of instruction are the lecture method, dramatization method, inquiry method, project and field trip, among others. Lecture method allows a great deal of information to be passed to the learner and favours handling of large classes. Inspite of this advantage, the lecture method does not stimulate students to develop scientific attitudes. It encourages students to cram facts which are easily forgotten according to Faniran, (1969) and Okwilagwe (2002). Based on this fact, there is the need to search and incorporate modern instructional strategies, which the advanced world has long accepted in their school system which is cooperative learning strategy.

Cooperative learning is the instructional use of small groups in which pupils/students work together to maximize and gain from each other, Johnson and

Johnson, (1974) (1996). In cooperative learning pupils are expected to help, discuss and argue with one another, assess one another's current knowledge, and fill any gap in one another's understanding Slavin, (1995). Bruffee (1995) saw cooperative learning as a set of processes which help people interact together in order to accomplish a specific goal or develop an end product, which is usually content-specific. Kagan (1989) provided an excellent definition of cooperative learning by looking at general structures which can be applied to any situation. His definition provides an umbrella for the work of cooperative learning specialists. Kagan (1989) stated that the structural approach to cooperative learning is based on the creation, analysis and systematic application of structures, of organizing social interaction in the classroom.

According to Amosun (2002), a number of research works have been carried out on the efficacy of cooperative learning in Nigeria. Such studies include those of Okebukola (1992), Adebiosu (1998) and Esan (1999). Omosehin (2003) investigated the effects of a training programme in cooperative learning of pre-service teachers' classroom practice and pupils' learning outcomes in social studies. It was found from the study that cooperative learning strategy seemed more useful than other instructional strategies.

Moreover, cooperative learning involves a small group of learners who work together as a team to solve a problem, complete a task or accomplish a common goal (Newman, Nath and Rock, (1990). There are many different cooperative learning techniques. However, all of them have certain elements in common, as established by Johnson, Johnson and Hollubec (1986). These elements are the ingredients necessary to ensure that when students do work in groups, they work cooperatively. Firstly, the members of a group must perceive that they are part of a team and that they all have a common goal; secondly, group members must realize that the problem they are to solve is a group problem and that the success or failure of the group will be shared by all members of the group; thirdly, to accomplish the group's goal, all students must talk with one another to engage in discussion of all problems. Finally, it must be clear to all that each member's individual work has a direct effect on the group's success. Teamwork is of utmost importance.

Learning interaction and outcomes in cooperative learning can be influenced by differences among group members. The interaction in the group can be smothered by the size or composition of the group. According to Kagan (1989), the most appropriate number of group members is four: with an increasing number of group members, there is a greater possibility that one or more

members will not participate. The interaction is also affected by individual differences of group members in terms of abilities, perceived status in the group, cognitive style, introversion-extroversion, and socially-based differences, e.g. gender differences (Wiegmann, Dansereau and Patterson, 1992; Cohen, 1994).

Wachanga and Mwangi (2004) found no significant differences between boys and girls who were exposed to cooperative learning in chemistry. In addition, boys and girls in the experimental groups who were instructed through cooperative learning in chemistry outperformed their counterparts in the control group who were instructed through the traditional teaching approach. Muraya and Kimamo (2011) also observed that male and female students performed equally well when exposed to the cooperative learning approach.

Oyetunde (2003) opined that children differ in their abilities and performance levels. It is necessary that teachers should organize them into small groups in such a way that instruction is provided on a small level that will be of benefit to each student. Webb (1982) in Gillies and Ashma (1992) found that high ability students gave more help to their peers in mixed ability groups than they did in uniform ability groups. Conversely, medium-ability students gave and received more explanation in uniform ability groups than they did in mixed ability groups.

Gillies and Ashma (1992) in their study of effect of gender and ability on students' behaviour and interaction in classroom-based work groups, had 440 participants in the study, 6 children each participated and worked on class-based activities in small groups structured so that all the members had to cooperate in order for the group to achieve its academic objectives. Contrary to expectation and the findings of other researchers, the effects of different ability and gender compositions in the group on the members' behaviour and interaction were minimal. Findings showed that the group members irrespective of gender and ability, had more time to work together; they became more responsive to the needs of each other and gave more explanations to assist one another's learning so that all groups achieved comparable learning outcomes.

Adesoji (1995, 1997) discovered that problem-solving and cooperative learning strategies are effective in teaching students of different ability levels. This is because they will help them to develop social skills which will improve their content knowledge and achievement in the subject.

A synthesis of researches on the influences of gender and ability on cooperative learning outcomes indicated similar findings in all. Studies by Johnson, Johnson and Stanne (1986), Glassman (1989), Crosby and Owens (1993), Bramlet (1994), Megnin (1995), Stevens and Slavin (1995), Webb, Trooper and Fall (1995) and Ajaja and

Eravwoke (2010) found that cooperative learning gains are not limited to a particular ability level or sex but to all who engage in it. Stevens and Slavin (1995), for example, linked cooperative learning to increased academic achievement of learners at all ability levels, while studies by Johnson, Johnson and Stanne (1986) and Glassman (1989) found cooperative learning to equalize the status and respect for all group members, regardless of gender. Furthermore, the studies by Crosby and Owen (1993) and Ajaja and Eravwoke (2010) found that different cooperative learning strategies can be employed to help low ability students to improve achievement, who had difficulties making success in the conventional classroom situation.

Evidences from research works in Nigeria indicated that very little research efforts had been directed at cooperative learning. But this approach to teaching has been recommended for teaching at all levels, as stated by the Federal Government of Nigeria (2004) in the National Policy on Education. This, therefore, tends to suggest that as most teachers are not sensitized on the advantages of the use of cooperative learning, it is believed that the manner in which most schooling occurs may not be teaching students to become aware of their own learning, to think critically and to derive their own pattern of thought through interaction as a result of cooperative learning.

One important reason for the inconsistent implementation of the cooperative learning may be an imperfect understanding of what the method really is. The study by Sparapani (1997) showed that teachers learn about cooperative learning incidentally rather than intentionally. Studies concerning how teachers actually use cooperative learning in the classroom also suggest that attention needs to be paid to training the essential features of cooperative learning (Antil, Jekins, Wayne and Vadasy, 1998; Johnson and Johnson, 1999). For teachers to acquire cooperative strategies, they must first be incorporated into teacher education programmes and demonstrated accordingly. Moreover, the instructional techniques should be placed at the core educational curriculum to promote academic achievement and development of appropriate social skills (Hillkirk, 1991). Hence this study.

Statement of the Problem

Over the years, the method of science teaching has been the lecture method. This is a method where content materials are presented to students in their final forms. The results of students in science and particularly basic science have not been encouraging as demonstrated in annual chief examiners' reports of JSSCE 2003-2008 (Ale, 2008). This development indicated an instructional

method failure and a need for an alternative method, which can guarantee effective learning by students.

Following the qualities ascribed to cooperative learning by researchers as being able to enhance science learning, its use as an alternative instructional approach for basic science teaching becomes a necessity. The problem which this study sought to solve is: Will the application of cooperative learning strategy in the teaching of basic science produce better learning outcomes and guarantee equal achievement of students of different sexes and abilities?

Research Questions

The study was guided by the following research questions.

1. Is there any difference in achievement test scores in basic science between the students exposed to cooperative learning strategy and those taught using the lecture method?
2. Is there any difference in achievement test scores in basic science between male and female students exposed to cooperative learning strategy?
3. Is there any difference in achievement test scores in basic science between the high and low ability students exposed to cooperative learning strategy?
4. Is there any difference in achievement test scores in basic science between high ability students exposed

to cooperative learning strategy and the high ability students taught with lecture method?

5. Is there any difference in achievement test scores in basic science between male and female students exposed to lecture method?
6. Is there any difference in achievement test scores in basic science between low ability students exposed to cooperative learning strategy and the low ability students taught with the lecture method?
7. Is there any interaction effect between method and gender on students' achievement test scores in basic science?
8. Is there any interaction effects between method and varying abilities on students' achievement test scores in basic science?
9. Is there any interaction effects between methods, gender and ability on students achievement test scores in basic science?

Research Hypotheses

The following null hypotheses were formulated for testing at the 0.05 level of significance.

$_1$: There is no significant difference in basic science achievement test scores between students exposed to cooperative learning strategy and those taught using the lecture method.

H_2: There is no significant difference in basic science achievement test scores between male and female students exposed to cooperative learning strategy.

H_3: There is no significant difference in basic science achievement test scores between the high and low ability students exposed to cooperative learning strategy.

H_4: There is no significant difference in basic science achievement test scores among students of varying abilities exposed to cooperative learning strategy and those taught with the lecture method.

H_5: There is no significant difference in basic science achievement test scores between male and female students taught with lecture method.

H_6: There is no significant interaction effect between the method used in teaching the students and their gender on achievement in basic science.

H_7: There is no significant interaction effect between the method used in teaching the students and ability on achievement in basic science.

H_8: There is no significant interaction effect between the gender of the students and ability on achievement in basic science.

H_9: There is no significant interaction effect among methods, gender and ability of the students on achievement in basic science.

Purpose of the Study

The purpose of this study was to:

1. determine if cooperative learning method when used for instruction do influence students' achievement in basic science;
2. determine how the intervening variables such as gender and ability affect students' achievement in basic science in a cooperative class;
3. determine if there is any difference in achievement test scores between the students exposed to cooperative strategy and those taught with the lecture method;
4. determine the difference between male and female students exposed to the cooperative learning strategy;
5. determine if there is difference in achievement test scores among the varying ability students with respect to the different methods of instruction; and
6. determine whether there is interaction effect among method, ability and gender on students' achievement in basic science.

Significance of the Study

Findings from this study may provide basic science teachers with useful information on the use of cooperative learning to improve the acquisition of the knowledge

content and achievement of students in basic science. It may also help the teachers to change the long-standing practices of rote-learning/memorization and teacher-dominated instructional strategies.

The study may also add to the pool of local literature on cooperative learning and the campaign for its adoption for improving students' achievement in science. Curriculum planners may benefit, as the outcome of this study will help them to produce better curriculum materials that would improve the teaching-learning situation in science. Information provided by this study may enable the students of the Universal Basic Education 7 to 9 to show greater interest in basic science and thus provide a tool for national growth and development.

The State and Federal Ministries of Education and other agencies responsible for financing education in the country may benefit from the findings of this study. This is because information provided will enable them realize that adequate educational facilities and relevant instructional materials needed for cooperative learning strategies will enhance and improve achievement of students in basic science.

Scope and Delimitation of the Study

The study was limited in scope to six hundred and seven (607) students selected by simple balloting

technique from six government-owned secondary schools in Rivers State. Two secondary schools were selected from each of the three senatorial districts in Rivers state. The population of the study consisted of the 259 government-owned secondary schools of UBE-9 (JSS III) with a population of 35,251 students.

The topics where the achievement test scores were generated were the concept of heredity and environmental health, resources from plants and animals and methods of feeding etc as specified in Table 3 of specification of BSAT (Basic Science Achievement Test).

Limitations of the Study

From the timing, the following were seen as limitations.

1. The duration of the study did not cover a long period of time of at least 5 months, rather only five weeks were used. The time did not permit the students to express to the fullness their abilities.
2. Some of the basic science teachers were not always readily available for assistance.
3. The study was limited to few junior secondary school three (JS3) students in only six government owned secondary schools of UBE-9 in Rivers State.
4. The use of intact classes in a quasi-experimental study such as this could be a limitation to the study. However, the use of analysis of covariance with

pretest scores as covariate was used to control, the effects of initial difference between groups.

5. The study covered a limited time of five weeks in order not to disrupt the normal periods in the timetable of the schools used for the study. More units other than the once covered in the study could have been used to make for a better generalization of results obtained from the study.

Operational Definition of Terms

The terms or concepts used in this study are hereby operationally defined.

1 **Cooperative learning strategy:**- This refers to a teaching method in which students are placed in small groups to help one another learn academic contents.

2. **Basic Science:-** Is the type of science subject that students of UBE 7 to 9 are taught.

3. **Student Achievement:-** The scores students obtained in pencil and paper test.

4. **Effects:** Known as result, impacts, influences or creating impressions.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter presents the review of literature as it relates to cooperative learning strategies, gender, varying abilities and academic achievement of students in basic science.

Therefore, a look into how these variables affect the students achievements in basic science, is reviewed under the following headings:

- Theoretical framework of the study
- The concept of cooperation
- Components of a cooperative learning activity.
- Procedure for organizing cooperative learning
- Types of cooperative learning
- Empirical Studies on Cooperative Learning
- Gender and science achievement in Cooperative Learning Class
- Abilities and Science Achievement in Cooperative Learning class.
- Appraisal of Reviewed literature.

Theoretical Framework of the Study

This study was anchored on two major theoretical perspectives which have guided research on cooperative learning: namely, motivational and cognitive theories. The motivational theory of cooperative learning emphasizes students' incentives to do academic work, while the

cognitive theory emphasizes the effects of working together.

Motivational theory related to cooperative learning focuses on reward and goal structures. One of the elements of cooperative learning is positive interdependence, where students perceive that their success or failure lies within their working together as a group (Johnson, Johnson and Holubec, 1986). From a motivational perspective, cooperative goal structure creates a situation in which the only way group members can attain their personal goals; is when students are likely to encourage members within the group to do whatever that will help the group to succeed and to help one another with a group task.

There are two perspectives under the cognitive theory that are directly applied to cooperative learning:- the developmental and the Elaboration perspectives (theories). The Developmental theory assumes that interaction among students around appropriate tasks increases their mastery of critical concepts. When students interact with other students, they have to explain and discuss each other's perspective, which leads to greater understanding of the materials to be learned. The struggle to resolve potential conflicts during collaborative activity results in the development of higher levels of understanding.

The Elaboration theory suggests that one of the most effective means of learning is to explain the material to someone else. Cooperative learning activities enhance elaborative thinking and more frequent giving and receiving of explanations, which has the potential to increase depth of understanding, the quality of reasoning, and the accuracy of long-term retention (Johnson, Johnson and Hollubec, 1986). Therefore, the use of cooperative learning methods should lead to improved student learning and retention from both the developmental and elaborative theoretical bases.

The Concept of Cooperation

The concept of cooperation have certain elements in common as established by Johnson, Johnson and Hollubec (1986). These elements are the ingredients necessary to ensure that when students do work in groups, they work cooperatively: firstly, the members of a group must perceive that they are part of a team and that they all have a common goal. Secondly, group members must realize that the problem they are to solve is a group problem and that the success or failure of the group will be shared by all members of the group. Thirdly, to accomplish the group's goal, all students must talk with one another to engage in discussion of all problems. Finally, it must be clear to all that each member's individual work has a

direct effect on the group's success. Team work is utmost important.

Components of a Cooperative Learning Activity

According to Borich (2004) planning for cooperative learning requires decisions pertaining to the following teacher-student interaction, student-student interaction, task specialization and materials; and role expectations and responsibilities.

The primary goal of teacher-student interaction during cooperative learning is to promote independent thinking. The primary goal of student-student interaction during cooperative learning is to encourage the active participation and interdependence of all members of the class. The primary goal of task specialization and learning material during cooperative learning is to create an activity structure whose end product depends on the sharing, cooperation, and collaboration of individuals within groups. The primary goal of assigning roles and responsibilities during cooperative learning is to facilitate the work of the group and to promote communication and sharing among its members.

Procedure for Organizing Cooperative Learning

Ochonogor and Ajaja (2005) in Ajaja (2009) have identified the following steps in organizing co-operative learning:

a. The group structure should be such that:

(i) It consists of 5-7 members

(ii) It is heterogeneous in terms of gender, educational ability, physical ability, culture, socio economic status and religious background.

(iii) Members alternate their functions in the group.

(b) Students must be taught the social skills needed for high quality collaboration and motivated to use them.

(c) Students should periodically be given time and structure to analyze how well their learning group is functioning.

(d) Cooperatively structured lessons should be supplemented with competitive and individualistic learning.

(e) The teacher should monitor the task of group members with observation sheets.

(i) The group is functioning interpersonally.

(ii) Students are progressing in their academic tasks.

Structuring the cooperative learning task involves the following decisions:

1. How large the group will be.
2. How group members will be selected.
3. How much time will be devoted to group work.
4. What roles group members will be assigned.
5. What incentives will be provided for individual and group work.

Johnson and Johnson (1991) had identified the following methods for selecting group members in a cooperative class:

(a) Ask students to list peers with whom they would like to work

(b) Randomly assign students to groups

(c) Choose matched opposites: minority/majority, boy/girl/, with/without disabilities, and so on.

(d) Share with students the process of choosing group members (e.g. teacher selects first, then person selected chooses another, etc).

Johnson and Johnson (1996) stated that during the monitoring of the group performance, the teacher's role is to see that each group remains on track, to redirect group efforts when needed, and to provide emotional support and encouragement. They also indicated that during de-briefing, there are several ways to gather feedback in a whole-class discussion about the collaborative process, which include the following:

(a) Openly talk about how the group functioned during the cooperative activity.

(b) Solicit suggestions for how the process could be improved.

(c) Obtain the viewpoints of predesignated observers.

Types of Cooperative Learning (Team-Oriented Cooperative Learning Techniques)

Slavin (2001) indicates that teams of heterogenous learners can increase the collaborative skills, self-esteem and achievement of individual learners. As a result, four team-oriented cooperative learning techniques have been particularly successful in bringing about the outcomes enumerated above. These are: Student team-Achievement Division, Teams-Games-Tournaments, Jigsaw II, and Team-Assisted individualization.

Student Teams –Achievement Division (STAD)

In this technique, the teacher assigns students to four or five-member learning teams in a heterogenous structure composing of a representative of boys/girls, higher achieving/lower achieving, high socio-economic status/low socio-economic status etc.

This learning technique was developed by Slavin (1978). This makes use of students working together in four or 5 member heterogeneously grouped teams to help one another master content and prepare for competition against other teams. The teacher presents the new materials to be learnt and the team members work together studying from the work-sheets, through discussion, tutoring one another and quizzing one another to assess mastery. A member of the group is given answers

to all the questions or problems on the work sheet and he is also assigned to check the written or oral responses of others.

After the teams have had sufficient time to practice with the worksheet and answer key, individuals are given a written quiz over the material in which team members may not help one another. The quiz is scored immediately and individual scores are formed. The individual students contribution is determined by comparing his present scores with his previous scores or achievement history. This way, the entire group receives a score based on each individual member performance and individual learners also receive an improvement score based on the extent to which their individual score exceeds past performance or a pre-established standard that recognizes their learning history.

Students are assigned to three-person tables composed of students from different teams who are similar in achievement in a quiz competition. STAD combines cooperative learning task structure with team competition and group rewards for cumulative individual performance.

Teams-Games-Tournaments (TGT)

This is a cooperative learning technique closely related to STAD, which makes the use of teams-Games-Tournament (TGT). It uses the same format as STAD in which students working together in four-to-five member

heterogeneously grouped teams, help one another to master content and prepare for competitions against other teams.

This technique was developed by De Vires, Edwards and Wells (1974) and Davis, Slavin, Fenneseey, Edwards and Lanbardo (1980). However, instead of individually administered quizzes after four-to-five member groups studying worksheet as in the case of STAD at the end of a study period, students play academic games to show their mastery of the topic content.

Students earn points by answering questions correctly or by successfully challenging or correcting the answers of other students on the game tournament. The points earned by individual students at the game tournament are later summed up to determine each team's score. This incentive structure motivates students not only to master the materials on their own but also to help their mates master the materials.

Jigsaw II

This cooperative learning technique developed by Aronson, Blaney, Stephen, Sikes and Snapp (1978) is composed of heterogeneous structure of 4-to-6 member team who are assigned with academic task broken into several subtasks depending on the number of groups.

This technique ensures individual participation and group cooperation. A unique responsibility is assigned to

an individual member of a particular group whereas other members will be assigned to other sections of the task.

When all team members have seen their specific assignments, they will break out from their original group. Members from different teams or groups who are having similar assignment would meet together as expert groups to discuss their assignment and to share their conclusion and results. Once in an expert group, members may assist each other by comparing notes and identifying points overlooked by other group members. When all the expert groups have had opportunity to share, discuss and modify their conclusion, they will return back to their respective or original group.

Each member then takes turns teaching their teammates about their respective responsibility. Jigsaw II heightens interest among group members because the only way other team members can learn about topics to which they were not assigned is to listen to the teammate who received that assignment. After the expert teammates had finished their presentation to the team, individual quizzes was made to assess how much they have learnt. As it is applicable in STAD, both overall group score as well as individual improvement score based on past performance could be assigned.

Team Assisted Individualization (TAI)

This is one of the newest cooperative learning technique developed by Slavin, Leavey and Madden (1984). It combines some of the characteristics of individualized and cooperative learning.

In this technique, students are giving diagnostic test to determine the placement of the learning material based on their previous learning history. Thus, students may work at different levels depending on the heterogeneity of abilities in the classroom. This technique involves, giving each student a specified amount of content to work through at his or her own pace; and assign each learner to a team selected to represent all ability levels and, therefore, individual enter the individualized materials at different levels of complexity. Heterogeneity within the teams is important, because you then ask each team member to have his or her work checked by another teammate.

There are also checkers who had completed portions of the advanced learning materials than the other members in the group. The checkers help to check the answer responses of some weak members of the group. Student monitors give quizzes over each unit and scores are recorded on a master score card. Team quizzes are averaged and number of units completed are counted by the monitor to create team scores. One monitor is

assigned to each team to manage the routine checking, distribution of the individualized materials, and administering and recording the quizzes.

TAI uses individualized materials; it is especially useful for teaching heterogeneous classes that afford few opportunities for whole-class instruction and little time to instruct numerous small groups who may have diverse learning needs.

Empirical Studies on Cooperative Learning

Most studies in cooperative learning over the years have shown the effectiveness of cooperative learning strategies over the conventional method in the promotion of students learning and achievement (Bennett and Dunne, 1974; Crook 1994 and Slavin 1995). Gibbs (1971) reviewing 106 studies on outcome effects associated with various kinds of group training found that most of them reported that group members improved in their academic achievement. Cannon-Bowers and Bowers (2008) also recorded that a meta-analysis of some 122 studies of classroom instruction showed that on the average, cooperative mode of learning students considerably outperformed competitive or individualized approach students.

Austin (2003) examined the results of a four-year longitudinal study of students at 159 institutions and

found that classroom pedagogical practices that promoted meaningful collaborative skills among students made a significant contribution to students' achievement. This supports earlier research results, which called attention to the link between instructional techniques of cooperative learning and different study outcomes. Kulik and Kulik (1999) on their extensive review of literature found class discussion, a central component of cooperative learning, leads to higher cognitive development, and long-term knowledge retention when compared with traditional pedagogy. Results from these researches comparing cooperative learning with individual learning, claimed benefits of better performance, better motivation, higher test scores and higher achievement and development of high level thinking for cooperative learning than individual learning or the conventional method of teaching.

Johnson and Smith (2000) in a meta-analysis of studies among college students revealed positive correlation between cooperative learning and achievement-among these students.

An empirical study by Gokhale (1995) examined the effectiveness of individual learning versus cooperative learning in enhancing drill and practice skills and critical thinking skills. The subjects, secondary school students were divided into two classes of 40 students each for individual learning and cooperative learning. Cooperative

learning groups of four each were constituted by self-selection. Classes were given lectures after which they were made to work on the same worksheets, individually or cooperatively.

After the session, participants were then given a posttest. It was found that the mean of the posttest scores of three who studied cooperatively (13.56) was slightly higher than the group that studied individually (11.89). However, a t–test on the data did not show a significant difference between the two groups at 0.05 alpha levels. Covariance analysis on the test scores showed that the students who studied cooperatively (mean=12.21) performed significantly better on critical-thinking items than those who studied individually (mean = 8.63) as it yielded an F-value of 3.69 which was significant at $P < 0.001$. It was however found that both groups did equally well on the drill-and-practice test items. This result is in agreement with the learning theories proposed by Vygotsky 1978.

Empirical study by Issroff, Scanlon and Jones (1997) used 11 individuals and 22 pairs of secondary school students, who using a chemistry database were required to fill in a work sheet about the periodic table. The task was defined by a worksheet consisting of questions that required mere information as well as those that require the students to reason about the information obtained. Two

different paired conditions were created, one requiring the pair to share a worksheet and the other, each student having his own worksheet. Pre, post and delayed post-cognitive test were carried out. The study found in terms of pre-to-post and pre-to-delayed posttest gains, a significant advantage to working in pairs, especially those who shared worksheet, with respect to on-task performance were identified.

Cavalier, Klein and Cavalier (2005) in a quasi-experimental study used intact classes, which they assigned to either a cooperative learning treatment or control/conventional instruction treatment both of which were taught by the same teacher. Assessment included a post-test, attitude survey, and group interaction behaviours. ANOVA was used to compare posttest scores of the two groups and MANOVA was used to analyze group differences between social and cognitive interaction behaviours. Findings showed that practice in a cooperative group as well as higher level of social and cognitive interaction resulted in a better achievement among the group members.

Sherman, Thomas and Kelvin (2006) in their study involving high school general mathematics students, found that the classes taught by the cooperative method performed better than the individualistic class.

Thornton (1991), using three goals structures, found that cooperative learning was particularly effective for students with special learning needs in mathematics. Mulryan (1995) had similar results. Carroll (1991) also compared the use of cooperative learning and lecture methods in teaching written business communication and found that there was an improved interpersonal relationship among the cooperating students and their performance was also improved.

Kempa and Ayob (1995) cited in Pepple (2010) examined how effective group work is in promoting learning outcomes and found that a reasonable level of academic achievement resulted from group activities. In the same vein, Zisk (1998) also in a study examined whether or not using cooperative learning method in high school chemistry class would significantly increase students' academic self-concept and academic achievement. A total of 49 secondary students were used. 25 in the control group and 24 in the experimental group. The result showed that the subject exposed to the cooperative learning strategies showed an improved self-concept than the students in the control group. It also indicated that the students in the cooperative class performed better than the students in the control group on achievement test. The study demonstrates that cooperative

learning strategies promote a greater sense of academic self-concept and academic achievement in students.

Humphrey and Johnson (1982) carried a comparative study on cooperative, competitive and individualistic strategies in science classes and found that students, who were taught by cooperative learning methods, learn and retain significantly more information than students taught by other two methods. In corroboration to this findings of Humphrey and Johnson (1982), Slavin (1983) in a review of 46 studies related to cooperative learning, found that cooperative learning resulted in significant positive effects in 63% of the students and only two studies reported higher achievement for the comparison group.

Slavin (1990) also reported that of the 70 high-quality studies that evaluated various cooperative learning methods, 60 of them measured effects on students' achievement. On the whole, 42 studies (62%) found significantly greater achievement in cooperative classes than in control classes. 23 studies (34%) found no significant differences, while only three studies reported the control group performing better than the experimental class.

Other studies of note in the Nigeria setting on the cooperative learning strategies are as follow: one of them is by Alebiosu (1998) who investigated the comparative effects of two models of cooperative learning (Jigsaw II and

STAD) and the conventional teaching method, which served as control. The result showed that students taught by the two cooperative learning techniques had better cognitive achievement than students in the control group.

Also, the study conducted by Iroegbu(2000) indicated that students exposed to problem-based learning (PBL) using the cooperative learning strategies had the highest mean score of 5.47, as against 1.99 for the conventional method that served as control. He also noted that the cooperative learning strategies guaranteed acquisition of useful skills and concepts and development of positive attitude and behaviour on the students.

Pepple (2010) in a study to determine the effects of cooperative learning style and programmed instructional strategy on students' learning outcomes in chemistry indicated that cooperative learning style was more effective in promoting students' achievement in and attitude toward chemistry than the programmed instructional strategy and the conventional lecture method.

The academic achievements of students have been found to be enhanced by the use of cooperative learning and it also increases the academic achievement of learners at all ability levels (Johnson and Johnson, 1989; Webb, 1989; Slavin, 1990, 1991, Stevens and Slavin, 1995, Lampe, Rooze and Tallen-Runnel, 1998) cited in Ajaja and Eravwoke (2010). It had also been noted that cooperative

learning activity engages the students in the learning process, which improves the critical thinking, reasoning, and problem solving skills of the learner (Bramlett, 1994; Megnin, 1995; and Webb, Trooper and Fall 1995). Lampe, Baker and Kose (1998) emphasized again that as learners, some who might normally refuse to speak out in a traditional setting, become actively involved in the learning process through group interaction. Stahl and Vansickel (1992) cited in Ajaja and Eravwoke (2010) noted that every cooperative learning strategy, when used appropriately, can enable student to move beyond the text, memorization of basic fact and learning lower level skills. This method which results in cognitive restructuring leads to an increase in understanding of all students in a cooperative group.

In addition to academic achievement benefits, cooperative learning has been found to promote self-esteem, interpersonal relationship and improved attitudes toward school and peers (Johnson and Johnson, 1996). Lampe, Baker and Kose (1998) stated that in a competitively structured classroom, except for the few "winners" or student who succeeds, self-esteem can suffer. When competition is promoted, students may learn to involve wining at all costs, and cooperation may be discouraged (Lampe, et al 1998; Conrad, 1998). Although the advocates of cooperative learning are not opposed to all

competition, they do oppose inappropriate competition (Johnson and Johnson, 1991, 1996). Stahl (1992) stated that inappropriate competition tends to widen the existing differences and abilities, which in turns can widen negative perceptions of others on the basis of gender, race, or ethnicity. Ajaja and Eravwoke (2010) in a study on the effects of cooperative learning strategy on junior secondary school students achievements in integrated science noted that cooperative learning influenced the academic achievement of students of varying ability levels, and there was no significant difference on the achievement of the learners based on their gender; hence it is the purpose of this study to determine the influence of the cooperative learning strategy and lecture method on students achievement in basic science. And also the interaction effects of the instructional method with gender and varying abilities.

Gender, Science Achievement in Cooperative Learning Class

Gender issue is an inconclusive case in science achievement. While some researchers see boys performing better than girls, others see girls performing better than boys. The interrelationship between gender and science achievement has been that which has received a wide research in the recent past.

Kelly (1987) in his work which focused on lack of girls' interest to study the physical sciences stated that girls have sustained interest in sciences like boys. Scoffled (1994) and Erinosho (1995) believed that gender had a great influence on achievement and attitude of the females participation in sciences.

Other research works have equally established significant gender difference in science education in favour of boys. Postlethwaist and Wiley (1999) also reported that boys performed better than girls in science.

Onocha (1995) found sex of pupils as one of the variables that effectively predicted primary school pupils' attitude towards science and science achievement. This was confirmed by Obioma (1996), Okpala and Onocha (1998) who found gender as a significant determinant of students achievement in physics. Yoloye (1998), Jones (1999) and Kotte (2002) working on science achievement between boys and girls confirmed that boys tend to perform better than girls.

Wang and Andre (2001) investigated the relationship between conceptual change approaches and gender. They found an overall gender effect. The concept investigated was electricity. They hypothesized that an average men had a higher-level interest in electricity than women. On the other hand, Ige (2008) found no significant main effect of gender on students' learning outcomes, in secondary

school ecology. However, a significant interaction effect of teaching strategy (treatment) and school setting on students cognitive achievement was found (Agboghoroma, 2005).

Iroegbu (2000) also found no significant main effect of gender on students' achievement in energy concepts in physics, but reported interaction effects of treatment and gender as well as gender and numerical ability on students' achievement in energy concepts in physics.

Mullis and Jenkins (1998) reported that, interest in science is high for both male and female students in elementary schools, but declined particularly for females in the middle secondary school years. Funk (2004) states that in co-educational schools, the competitive manner in which science is typically done may contribute to females decreased interest. Ransom (2002) in his study, discovered that gender actively reinforced boundaries through perceptions of certain subjects as being male or female. Both boys and girls use each other as a negative reference group in the maintenance of gender boundaries. Shepherds (2003) is of the view that in order to improve the achievement and attitude of the female students in sciences, feminine traits such as feeling and receptivity, cooperation, relatedness and social responsibility in studying science should be encouraged. This was supported by Baker (2005):

Some people believe (without any empirical support) that because men are regarded as dominant and even superior sex, they intrinsically have better brains and learn much better than women (Mkpughe, 1998 cited in Okoye, 2009). This view tends to be in line with that of Rosenthal and Rubin (1982) and that of Hyde (1981) that differences between male and female students in intellectual performance in schools have been demonstrated on a wide range of variables; Maccoby and Jacklin (1974) concluded that gender differences were well established. Girls have greater verbal ability than boys; and boys have better visual spatial ability than girls. Other research studies show that observed differences had not always favoured one gender. In Nigeria, considerable efforts have been expanded on trying to see how gender effects can be implicated in the seemingly poor performance of girls in integrated science (Ukwuagwu, 2002 cited in Okoye, 2009).

Ariyo (2001) pointed out that the issue of gender difference need further examination since a number of studies especially in Africa have reported that girls are under represented in the field of science and technology at secondary and tertiary institutions level (Alele-Williams, 1999). Gender difference was first investigated by sociologist of education. The focus was largely on female under achievement at every level of the educational

system. Therefore, there is the need to promote the teaching and learning of science in schools especially among female students. Ajeyalemi (1990) identified the following factors as contributing to under representation of females in science and technology education in Africa;

- Lack of functional guidance and counseling services,
- relationship of sex to occupational prestige,
- influence of schooling,
- family background,
- interest,
- training opportunities,
- lack of adequate orientation programme,
- societal discrimination against females in education,
- occupational choice and adaptation of science and technology.

Fakorede (1999), in his own contribution posited that poor enrolment of girls in science subjects is due to:

- inadequate opportunity for girls to study science,
- inadequate achievement of girl in science,
- unfavourable attitude of girls to science learning and,
- inadequate knowledge of girls on the true nature of science.

The critical belief of biological theorists is that gender differences are natural and therefore unalterable (Olubunmi, 2001 cited in Ariyo, 2011). It would be right

and proper to treat boys and girls in schools differently because their natural inclinations are different roles.

The above reviewed literature had not investigated the influence of gender on student's achievement in a cooperative learning class, which is one of the purposes of this study. It is important to review some of the studies in this regard.

Kolawole (2007) in a study on the effects of competitive and cooperative learning strategies on academic performance of Nigerian students in science, stated that the male students performed significantly better than their female counterparts in learning science with cooperative and competitive learning strategies. There is a gender influence with respect to performance in science through cooperative and competitive learning strategies.

Akinbobola (2006) showed that boys performed significantly better than girls in cooperative learning strategy. Studies by Johnson, Johnson and Stanne (1986); Glassman (1989); Johnson and Johnson (1996) and Trowbridge and Bybee (1996) on cooperative learning found cooperative learning groups to equalize the status and respect for all members, regardless of gender. Research by Klein (1985) cited in Ajaja and Eravwoke (2010) revealed that competitively structured classroom

have the effect of favouring boys or reinforcing sex role stereotypes that may limit opportunities for girls.

In cooperative learning this usually is not the case; where interaction among students is intense and prolonged and students gradually take responsibility for each others learning (Borich, 2004).

Humphrey, and Johnson (1982) and Akinbobola (2006) in different studies on cooperative learning strategy indicated that boys performed significantly better than girls in cooperative learning and competitive learning strategies.

This report was also in line with the reports of Adeyemi (2003) and Kolawole (2007).

Students' gender can influence interaction in cooperative learning groups when groups are not balanced according to this variable. Webb (1982,1989) found gender influence on interaction and achievement in sixth and seventh-grade students in mathematics. In groups with girls in majority, girls allotted most of their messages to boys and they had lower achievement than boys. In groups where boys were in majority, boys showed the tendency to ignore girls and at the same time, boys had higher achievement. It was also found that there is a higher possibility to get an elaborate answer and explanation when the question is directed to a girl. These

differences were not found in the groups of students that were balanced according to gender.

Peterson, Johnson and Johnson (1991) found similar results for sixth-grade students in science. In groups, balanced according to gender, there were no differences in achievement, group interaction, and perceived status. But boys got higher results in predominantly female groups and girls achieved higher results in predominantly male groups. Boys in female groups also got instructions how to finish task than boys in male groups.

Garduno (2001) investigated gender differences in cooperative problem solving in gifted students. She found no statistically significant differences in achievement or self-efficacy in seventh-and eight-grade students in mathematics in single – or mixed-gender groups. But female from mixed-gender groups reported better attitudes towards mathematics than females from single-gender groups at the end of the study. Females from mixed-gender groups also reported better attitudes towards mathematics than males from mixed-gender groups.

Other studies have also examined the influence of gender on students' achievement. For example, Olatoye and Adekoya (2009) found no gender difference in academic achievement of students exposed to different teaching strategies in science. Okebukola (1985) found no gender difference in academic achievement in cooperative

and competitive learning groups. However, Oyedeji (1991) reported the significant influence of gender on academic achievement with boys having better scores than girls in the study.

Olatoye, Aderogba and Aanu (2011) found non-significant effect of gender on students' achievement and also non-interaction effect of gender with treatment of cooperative learning strategy.

It is the purpose of this study to look at the effects of gender and its interaction effects with other variables such as the methods of instruction and varying abilities of basic science students achievement in UBE.

Ability and Science Achievement in a Cooperative Learning Class

Salami (2000) discovered that student's performance depends on its cognitive ability. Studies have shown that learners are quantitatively different in their ability levels and in solving problems (Adesoji, 1997; Chang and Moa, 1998; Iroegbu, 2000). Iroegbu (2000) ascertained that method of instruction can improve the achievement of students of different ability levels.

Alant (2004) studied students' intellectual ability and discovered that students of varying ability levels performed differently depending on the type of method of instruction. Adesoji (2002) opined that, students are not the same

especially when we find out the rate at which facts and principles in sciences are being assimilated. Okebukola (1992) confirmed that the use of appropriate instructional strategies can influence the performance of low achieving students.

Folashade and Akinbobola (2009) in a study on constructivist problem based learning technique and the academic achievement of physics students with low ability level in Nigeria showed that the physics students with low ability level taught with problem based learning technique performed better than those taught with conventional lecture method.

Several studies have focused on the question of which students gain the most from cooperative learning. One particularly important question relates to whether cooperative learning is beneficial to students at all levels of prior achievement. It would be possible to argue that high achievers could be held back by having to explain material to their low-achieving group mates (Robinson, 1990; Allan, 1991).

However, it would be equally possible to argue that because students who give elaborated explanations typically learn more than those who receive them (Webb, 1992); high achievers should be the students who benefit most from cooperative learning because they give the most frequent elaborated explanations.

The evidence from experimental studies that met the inclusion criteria for this review support neither position. A few studies found better outcomes for high achievers (abilities) than for low achievers (abilities) and a few found that low achievers gained the most (Slavin, 1995). Most, however, found equal benefits for high, average, and low achievers in comparison to their counterparts in control groups. One two-year study of schools using cooperative learning most of their instructional day found that high, average, and low achievers all achieved better than controls at similar achievement. Stevens and Slavin (1995) linked cooperative learning to increases in academic achievement of learners at all ability levels, while studies by Crosby and Owen (1993) and Ajaja and Eravwoke (2010) found that different cooperative learning strategies can be employed to help low ability students to improve achievement, who had difficulties making success in the traditional classroom.

Again, the ability levels of students have been found to play a major role in their achievement and so it is equally included as a variable. The ability of a learner is a construct, which many researchers have found to affect the achievement of learners (Aremu 2001). It has been discovered that learners of varying ability levels perform differently depending on the types of methods and materials used for instruction. Ande, (1990) and Aremu

(2001) cited in Ofodu and Lawal (2011) opined that this area of study has been a long time area of interest in actual research. But, most researchers rather than find which ability of learners perform better and what can be done to improve those who are not performing, have concentrated on providing approaches and materials that suit individuals abilities.

Reyes (1984) and Green (1990) cited in Ofodu and Lawal (2011) observed that low ability pupils need special attention in their work because usually their level of motivation towards learning is very low and attitude to learning is usually negative. Aremu (2001), therefore, suggests that there is need to develop strategies, method and materials that can increase motivation and attitude of such learners. Webb (1992) suggests that for children to feel successful, they need to become aware of their unique learning abilities and strengths so that they may apply these effectively while working to strengthen the lagging areas.

Students' abilities are variable that can affect group interaction and the outcomes of cooperative learning. The majority of research showed that learning in cooperative groups can be beneficial to high, medium, and low ability students (Amaria, Brain and Leith, 1969; Cohen, 1994). O'Donnell and Dansereau (1992) found that students in heterogeneous ability dyads had higher achievement than

students who learnt in homogeneous ability dyads. Krajnik (2002) found no difference in achievement in seventh grade students who learned chemistry with computer based cooperative learning in homogeneous-or heterogeneous-ability pairs. Barrett (2000) found higher achievement in sixth grade students who learned in heterogeneous pairs and in homogeneous high-ability pairs in computer-based cooperative learning instruction, but, lower achievement in homogeneous low-ability pairs.

Webbs (1980) and Swing and Peterson (1982) found positive influence of group heterogeneities for high- and low- and low-ability students, but not for medium-ability students. Bain and Lemke (1971) found that heterogeneous groups are better for students with high abilities than for students with low abilities. When interpreting these inconsistencies in the research results one has to consider the characteristics of interaction in heterogeneous and in homogeneous groups.

Webbs and Cullian, 1983; and Webb (1989,1992) found that in heterogeneous groups students with high abilities contribute more ideas and explanations than in homogeneous groups; in heterogeneous groups there is a higher possibility for the students with high and low abilities to get an answer to their question than in homogeneous groups. In heterogeneous groups with small differences in abilities, there is higher possibility for the

students with medium abilities to get an answer to a question, than in groups with large spread in abilities; in homogeneous groups there is a higher possibility that no one answers the question than in heterogeneous groups.

From the fore-going review, it could be taking that in cooperative learning strategy both high and low ability (achiever) could benefit equally due to the theories of motivation and elaboration that guide the cooperative learning strategy.

The ability of the students had been identified as one of the factors that influence students achievement in sciences from the various literatures reviewed. It is the intention of the researcher to see how the findings of this study could confirm the results of the reviewed literatures.

Appraisal of Reviewed Literature

Most literature reviewed were on effects of cooperative learning on other science subjects like mathematics, biology, chemistry and physics with none in basic science. However, only the study of Ajaja and Eravwoke (2010) showed the effects of cooperative learning on students' achievement in integrated science.

Most of the studies considered only its effects on achievement. There were very few studies on cooperative learning which considered the effects of cooperative learning on gender and students of varying abilities. The few studies in Nigeria which incorporated the elements of

gender and ability in influencing students achievement taught with cooperative learning are those by Akinbobola (2006), Kolawole (2007) and Ajaja and Eravwoke (2010). Studies by these researchers compared the achievement of male and female students taught with cooperative learning. This is a clear indication of the dearth of information on how students' gender and ability influenced students taught with cooperative learning.

On cooperative learning generally, of the studies reviewed, most of them were carried out in Europe, America and Asia with very few in Nigeria. This situation therefore calls for more research efforts. These are the gaps this study set out to fill in our knowledge of cooperative learning and its effect on students' achievement in Basic science.

CHAPTER THREE
RESERCH METHOD AND PROCEDURE

This chapter described the research design, the variables of the study, the sample and sampling techniques, research instruments, validation of instruments, reliability of the instrument, treatment procedure, and procedure for data collection and data analysis.

Design of the Study

The study employed a 2x 2x2 non-randomized pretest, post-test control group quasi-experimental design. This consisted of two instructional methods of cooperative learning strategy and the lecture method, gender at two levels of male and female, and varying abilities at two levels of high and low. The design can further be elaborated symbolically as shown below:

0_1 x 0_2 (E)

0_3 0_4 (C)

Where 0_1, 0_3 represent pre-test for experimental and control groups respectively; whereas 0_2 and 0_4 represent the post test for experimental and control groups respectively.

X: represents treatment

E: represents experimental group

C: represents control group.

Table 1 Representation of the variable matrix of the design.

		Treatments	
Ability Levels	Gender	Cooperative learning strategy (experimental group)	Lecture method (control group)
High, low	Male, female	0_1 X 0_2	0_3 O_4

Variables of the study are:

1. The independent variable is the
   Instructional method
   - Cooperative learning strategy (CLS)
   - Lecture method (LM)
2. Moderator or intervening variables are:
   Gender at two levels of: Male and Female
   Ability at two levels of: High and Low
3. The dependent variable is the scores or achievement in basic science achievement test (BSAT).

Population of the Study

The population for the study consisted of all 259 government-owned (UBE-9) secondary schools in Rivers State with a population of 35,521 students, as shown in Table 2.

Table 2 Showing the Local Government Areas, Senatorial Districts, Number of Secondary Schools in each LGA and the population of students.

S/No	Local Government Area (LGA)	Total of UBE Schools	Population of students
Senatorial District Rivers South East			
1	PHALGA	10	1321
2	OBIO/AKPOR	10	1135
3	KELGA	13	15 30
4	EMOLGA	22	4060
5	ETCHE LGA	12	1470
6	OMUMA LGA	10	1165
7	OKRIKA LGA	10	1404
8	OGU/GBOLO LGA	8	1015
Senatorial District Rivers West			
9	ABUA/ODUAL	14	2626
10	AHOADA EAST	13	2450
11	AHOADA WEST	12	1286
12	OGBA/EGBEMA/NDONI	14	2552
13	ASARI TORU LGA	12	1340
14	AKUKU-TORU LGA	10	1160
15	DEGEMA LGA	7	896
Senatorial District Rivers East			
16	TAI LGA	10	1343
17	ELEME LGA	10	1134
18	GOKHANA LGA	14	1662
19	KHANA LGA	12	1414
20	OYIGBO LGA	10	1135
21	BONNY LGA	8	986
22	OPOBO /NKORO LGA	8	992
23	ANDONI LGA	10	1145
	Total	**259**	**35,521**

Sources: Planning and Statistics Division, Rivers State Universal Basic Education Board, Port Harcourt, 2012.

Sample and Sampling Techniques

Only two Secondary schools were selected from each of the three senatorial districts in Rivers State, giving a total of six secondary schools using simple balloting technique for the selection.

Only the Universal Basic Education (UBE)9 or the Junior Secondary Class three (JS III) of mixed (Co-education) schools was used for the study. Two arms of UBE9 (JSIII) of the selected secondary schools were used for the study. One arm of the JS III served as experimental group, while the other arm served as the control group.

Research Instruments

Three research instruments were used for the study and they include:

1. Scholastic Ability Test in Basic Science (SATBS) (see appendix I, page 123).
2. Basic Science Achievement Test (BSAT) (see appendix II, page 137).
3. Cooperative learning manual (see appendix IV, page 151).

Development of the Research Instruments

(i) Scholastic Ability Test in Basic Science (SATBS).

The SATBS used in the study is the one developed by Rivers State Ministry of Education. The test items covered

all the major topics in basic science in the Nigeria National Curriculum for basic science.

The test instrument consisted of 50 multiple-choice items used to test students' knowledge of basic science at the end of JS III. The validation of the SATBS was determined when it was constructed by experts in Examinations and Records Department of Rivers State Ministry of Education. The reliability of the instrument was found to be 0.81. It was adopted by the researcher for this study.

(ii) **Basic Science Achievement Test (BSAT)**

This instrument was constructed by the researcher. The test instrument consisted of 50 multiple-choice items covering all the concepts of the units taught in the cooperative learning manual. The BSAT was made up of two parts, A and B. Part A covered the students' biodata such as the name of the school and gender, as well as type of instructional method and duration. Part B contained questions on the content area covered for the instruction during the cooperative learning strategy and the traditional teaching method (See appendix II, page 137).

Table 3 Table of Specification of BSAT

	TOPIC SECTION	Intellectual objectives (cognitive Domain)						
		Knowledge	**Comprehension**	**Application**	**Analysis**	**Synthesis**	**Evaluation**	**Total**
		48%	28%	10%	4%	4%	6%	100%
1	The concept of heredity and environmental health (14%).	3	3	1	-	-	-	7
2.	Resources from plants and animals and methods of feeding (28%).	6	4	2	-	1	1	14
3	Symbols of elements, chemical formulae, equations, Acids, bases and salts (24%).	7	3	1	1	-	-	12
4	Metals and Non-metals, extraction of metals, energy conversion and transfer (22%).	6	2	1	-	1	1	11
5	Concept of work, pollution, erosion and flooding, its control, weather and its related concepts (12%).	2	2	-	1	-	1	6
	Total	**24**	**14**	**5**	**2**	**2**	**3**	**50**

Validity of Research Instruments

The BSAT was given to five specialists in Science Education, Measurement and Evaluation departments of Rivers State University of Science and Technology, Rivers State University of Education and Delta State University Abraka. The BSAT was also given to some experienced English Language and basic science teachers in some secondary schools in Rivers State. They were given the instrument to vet each item for relevance, sentence structure and adequacy of the whole instrument, in order

to determine its face and content validity. They also looked at the test items in order to generate data that would answer the research questions and hypotheses.

Reliability of Research Instrument

The instrument was administered to an intact class of 52 students in JS III of the Community Secondary School, Nkpolu in Obio/Akpor Local Government Area of Rivers State. The internal consistency of the instrument was determined by the use of test-retest method for an interval of two weeks. Pearson product moment correlation coefficient was used to determine the reliability coefficient of the instrument which is 0.79 (See appendix III, page 150). (iii) Cooperative learning manual (See appendix IV, page 151).

The researcher-prepared manual was used by the cooperative group. The procedure for preparing the manual followed those suggested by Arends (1991). The guidelines used for operating the manual is stated in the manual.

Cooperative Learning Teaching Manual

The manual covered a period of five weeks with the lessons broken down into various periods. The manual was given to the students at the beginning of each lesson and collected at the end. The lesson for each period in a week is clearly marked out. At the end of each lesson,

brainstorming questions was provided which the students answered as a group and submitted a common solution. At the end of the lesson, the teacher marked each group's work and also collected back the manual.

Selection and Training of the Teachers of Experimental Group

Six basic science teachers from the selected government owned secondary schools having equal qualification, equal teaching experience and considerably equal teaching potential were selected for teaching basic science to the experimental groups. The teacher used for teaching the experimental group were provided two weeks training in cooperative learning i.e. one week for theory and one week for practical teaching. Contents of this training package included:

1. What is cooperative learning.
2. Experience with cooperative learning activities.
3. Class climate-building techniques.
4. Team-Building Techniques.
5. Strategies for students-centered learning.
6. Lesson planning.
7. Lesson sharing.
8. Social skills.
9. Implementation of STAD in the classroom.

Treatment Procedure for Experimental Groups

The teachers for the experimental group provided the students the training on cooperative learning activities in the classroom for five days, as follows:

=> **First Day:** The teacher assigned the students to cooperative teams under the supervision of the researcher and focused on the training of students in the following:

1. about cooperative learning
2. seating arrangement for STAD activities
3. about quiet signals
4. classroom rules
5. about schedules of STAD activities

=> **Second Day:** Teacher revised the activities learnt on the previous day by the question –answers technique. The teacher provided rehearsal to the students to get arrangement in the cooperative teams quickly. After proposed rehearsal teacher focused on the training of students in following aspects:

1. about social skills for group work.
2. about how to solve worksheet cooperatively.
3. about how to solve quiz sheet.

=> **Third Day:** Teacher provided two worksheets to each group about the previously learned unit of basic science and asked the students to solve the worksheets. Students started working on the work

sheets while teacher moved round in the class and watched the social skills, level of cooperation, level of interaction and level of participation. The teacher guided the students about these aspects from time to time. The teacher told the students about Quiz on next day.

=> **Fourth Day:** Students were arranged for test and a quiz sheet was given to students, students solved the quiz and returned their sheets to the teacher.

=> **Fifth Day:** Marked answer sheets were returned to each group and each group was provided a blank team score sheet. Students cooperatively filled their summary sheets. Then teacher provided them rehearsal in the following:

1. About achievement scores.
2. ABOUT total achievement scores of the team.
3. Criteria for supper team, excellent team and good team.

Thus the treatment continued in sequence-instruction with guided practice (one day) – STAD practice on worksheet (second day) and quiz (third day).

Cooperative learning method STAD consists of regular cycle of instructional activities, as follows:

- **Teacher:** Present the lesson.
- **Team study:** Students work on worksheets in their teams to master the material.
- **Test:** Students take individual quizzes.
- **Team recognition:** Team scores are computed based on team members' improvement scores and high scoring teams are recognized in the class.

The experimental group was divided into heterogeneous groups of four. For experimental group, each lesson proceeded in the following steps:

- The teacher presented the lesson using direct teaching for 80 minutes providing sufficient guided exercise according the lesson plan. (One day).
- On the second day, worksheets covering the contents of lesson taught on the previous day were provided to each cooperative group. The students worked on worksheets for 80 minutes in their teams to master the material (exercise).
- on third day, students took individual test (quizzes) for 30 minutes. In the next 50 minutes, tests were marked and team scores were computed on the basis of team members' improvement scores. High scoring teams were recognized in the class.

The treatment continued in three days cycle for 5 weeks.

Procedure for the Control Group

- Here, both the participating teachers and students were not exposed to the training of the cooperative learning technique, which was given to the experimental group.
- The scholastic ability test in basic science was given first to them in order to classify the students into high or low ability groups.
- The pretest using the basic science achievement test (BSAT) was given to this group of students before the actual lesson on topics through lecture method.
- The teacher only used the prepared lesson plan or notes by the researcher.
- The teacher presented the lesson in the form of lecture and demonstrations.
- Students listened to the teacher and wrote down chalkboard summary.
- Students asked the teacher questions on areas of the topic that were not clear to them.
- The teacher asked the students questions and the students answered individually.
- Thereafter, the posttest using the basic science achievement test (BSAT) was administered to the control group.
- This was given when the five weeks units of instruction had ended.

Method of Data Collection

The data for this study were obtained through:

1. Analysis of pretest-posttest scores of 318 cooperative learning students and 289 lecture method students.
2. Analysis of pretest-posttest scores of 146 male and 172 female students exposed to cooperative learning strategy.
3. Analysis of pretest-posttest scores of 133 high ability and 185 low ability students exposed to cooperative learning strategy.
4. Analysis of pretest-post-test scores of 133 high ability experimental group and 136 high ability control group students.
5. Analysis of pretest-post-test scores of 135 male students and 154 female students exposed to lecture method.
6. Analysis of pretest post-test scores of 185 low ability of experimental group and 153 low ability of control group.
7. Analysis of two way interaction effect between method and gender.
8. Analysis of two way interaction effect between method and ability.
9. Analysis of 3-way interaction effects among method, gender and ability.

Method of Data Analysis

The data generated were analyzed, using both descriptive and inferential statistics. Descriptive statistics used were means, standard deviations and graphs, while inferential statistic used was analysis of covariance (ANCOVA), using pretest scores as covariates. The ANCOVA partials out any initial difference in the independent variables and other extraneous variables that may have compounded the treatment effects. For significant 2-way interaction, graphs were used to explain the significant effect.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION

Presentation of Results

This chapter deals with the presentation of analyzed data, as well as the results or answers to the research questions and hypotheses stated in the study. The data and result of each research question and its corresponding hypothesis are presented in the different Tables.

Research question 1: Is there any difference in achievement test scores between students exposed to cooperative learning strategy and those taught using the lecture method?.

Table 4 Mean gain in achievement test scores between the experimental and control groups

Method	N	Pre-test Mean	SD	Post-test Mean	SD	Mean gain
Cooperative learning	317	30.73	13.60	61.60	14.38	30.84
Lecture method	289	29.46	14.20	38.80	17.62	9.34

Table 4 shows that the mean difference between the posttest and pretest scores (mean diff) was higher in the cooperative learning strategy. This implies that the cooperative learning group benefited more based on gain in learning achieved.

Research question 2: Is there any difference in achievement test scores between male and female students exposed to cooperative learning strategy?.

Table 5 Mean gain in achievement test scores between the male and the female students of the experimental group

Gender	N	Pre-test Mean	SD	Post-test Mean	SD	Mean gain
Male	146	32.98	14.11	63.95	14.38	30.97
Female	172	28.80	12.84	59.51	14.07	30.71

Table 5 shows the mean gains in achievement test scores of the male and the female students of the experimental group. The result indicates that gain in learning in both groups was almost the same for both sexes.

Research Question 3: Is there any difference in achievement test scores between the high and the low ability students exposed to cooperative learning strategy?

Table 6 Mean gain in achievement test scores between the high and low ability students exposed to cooperative learning strategy

Scholastic ability	N	Pre-test Mean	SD	Post-test Mean	SD	Mean gain
High	133	45.74	3.41	76.62	7.21	30.88
Low	185	19.92	5.37	50.71	5.97	30.79

Table 6 shows the mean gain in achievement test scores between the high and low ability students exposed to cooperative learning strategy. The result reveals that there were differences in achievement test scores between the high and the low ability students exposed to cooperative

learning strategy in favour of the students of high ability grouping. But there was no difference in their mean gain, hence the same magnitude of benefit between the two groups was observed.

Research Question 4: Is there any difference in achievement test scores between high ability students exposed to cooperative learning strategy and the high ability students taught with lecture method?

Table 7 Mean gain in achievement test scores between the students of high scholastic ability in the experimental and control groups

High Scholastic ability	N	Pre-test Mean	SD	Post-test Mean	SD	Mean gain
Experimental group	133	45.74	3.41	76.62	7.21	30.88
Control group	136	44.06	2.53	56.69	5.02	12.63

Table 7 shows the mean gain in achievement test scores between the students of high ability in the experimental and control groups. The result indicates that the high ability students in the experimental group gained (30.88) more than their control group counterparts (12.63). This indicates that the treatment was more beneficial to the high ability students of the experimental group.

Research question 5: Is there any difference in achievement test scores between male and female students exposed to lecture method?

Table 8: Mean gain in achievement between male and female students exposed to the lecture method.

Gender	N	Pre-test Mean	SD	Post-test Mean	SD	Mean Gain
Male	135	32.30	14.23	44.59	17.44	12.30
Female	154	26.97	13.75	33.71	16.20	6.74

Table 8 shows the mean difference in achievement test scores between the male and the female students of the control group. The result indicates that gain in learning in lecture method differed between the males and females.

Research question 6: Is there any difference in achievement test scores between low ability students exposed to cooperative learning strategy and the low ability students taught with lecture method?.

Table 9 Mean gain in achievement test scores between the students of low ability in the experimental and control groups

Low Scholastic ability	N	Pre-test Mean	SD	Post-test Mean	SD	Mean gain
Experimental group	185	19.92	5.37	50.71	5.96	30.79
Control group	153	16.48	4.02	22.89	4.96	6.41

Table 9 shows the mean gain in achievement test scores between the students of low ability in the experimental and control groups. The result shows that the low ability students in the experimental group gained (30.79) more than their control counterparts (6.41). That is to say that the low ability students in the experimental group

benefited more than their control counterparts due to the treatment (instructional method) used on them.

Research Question 7: Is there any interaction effect between method and gender on achievement test scores in basic science?

Table 10: Summary of Analysis of Covariance (ANCOVA) for the significant interaction effect between the methods used in teaching students and their gender on achievement in basic science.

Dependent Variable: POST_TEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	88461.600[a]	3	29487.200	122.882	.000	.379
Intercept	1532565.866	1	1532565.866	6386.677	.000	.914
GENDER	8833.835	1	8833.835	36.813	.000	.058
Instructional_Method	76762.648	1	76762.648	319.894	.000	.347
GENDER * Instructional_Method	1560.232	1	1560.232	6.502	.011	.011
Error	144697.662	603	239.963			
Total	1794471.000	607				
Corrected Total	233159.262	606				

a. R Squared = .379 (Adjusted R Squared = .376)

Table 10 above with (f (603) = 6.502 p <0.05) shows that there is interaction effect between method and gender on students' achievement-test-scores in basic science. The factors could interact to affect the achievement of student in basic sciences.

Research QUESTION 8: Is there any interaction effect between method and ability on students' achievement test scores?

Table 11: Summary of Analysis of Covariance (ANCOVA) for the significant interaction effect between method of instruction and ability on students' achievement test scores in basic science.

Dependent Variable: POST_TEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	212604.102[a]	3	70868.034	2078.963	.000	.912
Intercept	1596791.242	1	1596791.242	46842.989	.000	.987
Scholastic_Ability	132980.660	1	132980.660	3901.081	.000	.866
Instructional_Method	85062.165	1	85062.165	2495.358	.000	.805
Scholastic_Ability * Instructional_Method	2322.730	1	2322.730	68.139	.000	.102
Error	20555.160	603	34.088			
Total	1794471.000	607				
Corrected Total	233159.262	606				

a. R Squared = .912 (Adjusted R Squared = .911)

Table11 above with ($F(603) = 68.139$ $p < 0.05$) shows that there is significant interaction effect between method and ability on students achievement test scores. This implies that the factors could jointly, influence the students' achievement in basic science.

Research Question 9: Is there any interaction effect among method, gender and ability on students achievement test cores?

Table 12: Summary of Analysis of Covariance (ANCOVA) for the significant interaction among method of instruction, gender and ability on students' achievement test-scores in basic science.

Dependent Variable: POST_TEST

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	Hypothesis	2232.069	1	2232.069	3.190	.310	.746
	Error	759.164	1.085	699.646[a]			
Instructional_Method	Hypothesis	3432.048	1	3432.048	210.188	.000	.262
	Error	9682.784	593	16.328[b]			
Scholastic_Ability	Hypothesis	35.256	1	35.256	2.159	.142	.004
	Error	9682.784	593	16.328[b]			
GENDER	Hypothesis	.838	1	.838	.051	.821	.000
	Error	9682.784	593	16.328[b]			
Scholastic_Ability * Instructional_Method * GENDER * PRE_TEST	Hypothesis	10283.679	8	1285.460	78.725	.000	.515
	Error	9682.784	593	16.328[b]			

a. .195 MS(Instructional_Method) + 1.000 MS(Scholastic_Ability) + .203 MS(GENDER) - .398 MS(Error)

b. MS(Error)

Table 12 above with ($F(593) = 78.725$ $P < 0.05$) shows there is interaction effect among method, gender and ability on students' achievement-test scores in basic science. This implies that these three factors jointly influenced on students' achievement test scores in basic science.

HYPOTHESES

H_{01}: There is no significant difference in basic science achievement test scores between students exposed to

cooperative learning strategy and those taught with lecture method.

Table 13: Summary of Analysis of Covariance (ANCOVA) on the significance of difference in basic science test-scores between students exposed to cooperative learning strategy and those taught using the lecture method.

Dependent Variable:POST_TEST

Source	Type II Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	221517.132[a]	3	73839.044	3846.646	.000	.950
Intercept	29758.378	1	29758.378	1550.263	.000	.720
Instructional_Method	21457.894	1	21457.894	1117.849	.000	.650
PRE_TEST	141155.834	1	141155.834	7353.516	.000	.924
Instructional_Method * PRE_TEST	1604.831	1	1604.831	83.604	.000	.122
Error	11555.807	602	19.196			
Total	1790871.000	606				
Corrected Total	233072.939	605				

a. R Squared = .950 (Adjusted R Squared = .950)

Figure 1 Graphic illustration of significance of difference in basic science achievement test scores between students exposed to cooperative learning strategy and those taught using the lecture.

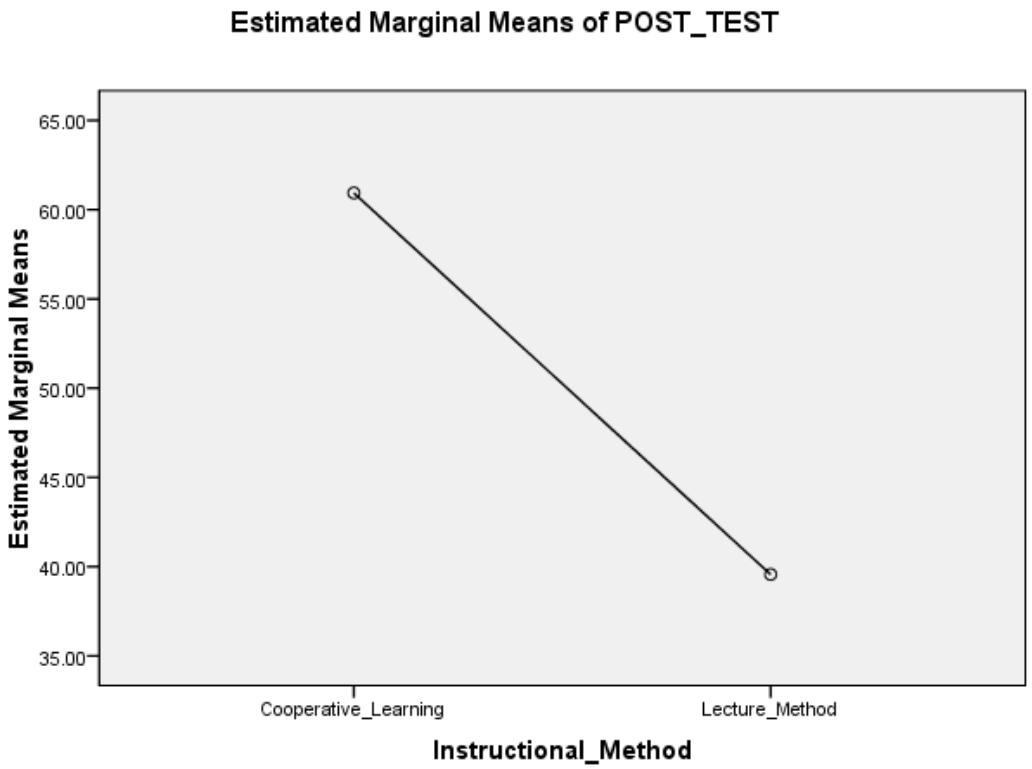


Table 13 with (F (602) = 83.604 p <0.05) and fig 4.1 indicate that there is significant difference in basic science achievement test scores between students exposed to cooperative learning strategy and those taught with lecture method. Thus, the null hypothesis of non-significant difference was rejected. This implies that the cooperative learning strategy was a better teaching method since the students using this method performed significantly better than students in the lecture method.

$H0_2$: There is no significant difference in Basic science achievement test scores between male and female students exposed to cooperative learning strategy.

Table 14: Summary of Analysis of Covariance (ANCOVA) on the significance of difference in basic science test scores between male and female students exposed to cooperative learning strategy.

Dependent Variable: POST_TEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	56715.494[a]	3	18905.165	686.173	.000
Intercept	49237.772	1	49237.772	1787.111	.000
GENDER	11.781	1	11.781	.428	.514
PRE_TEST	55097.069	1	55097.069	1999.778	.000
GENDER * PRE_TEST	25.464	1	25.464	.924	.337
Error	8651.201	314	27.552		
Total	1270091.000	318			
Corrected Total	65366.695	317			

a. R Squared = .868 (Adjusted R Squared = .866)

Table 14 above with (F (314) = 0.924 P> 0.05) showed that there was no significant difference in basic science achievement test scores between the male and female students exposed to cooperative learning strategy. This implies that the treatment was a suitable method for both gender (sexes). It did not constitute any differential achievement test scores in basic science between the male and female students. Thus, the null hypothesis of non-significant difference was retained.

Ho_3: There is no significant difference in basic science achievement test scores between the high ability and low ability students exposed to cooperative learning strategy.

Table 15: Summary of Analysis of Covariance (ANCOVA) on the significance of difference in basic science achievement test scores between high and low ability students exposed to cooperative learning strategy.

Dependent Variable: POST_TEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	56836.375[a]	3	18945.458	697.380	.000
Intercept	3745.775	1	3745.775	137.882	.000
Scholastic_Ability	28.175	1	28.175	1.037	.309
PRE_TEST	3281.935	1	3281.935	120.808	.000
Scholastic_Ability * PRE_TEST	3.964	1	3.964	.146	.703
Error	8530.320	314	27.167		
Total	1270091.000	318			
Corrected Total	65366.695	317			

a. R Squared = .870 (Adjusted R Squared = .868)

Table 15 with (F(314) = 0.146 P > 0.05) shows that there was no significant difference in basic science achievement test scores between the high and low ability students exposed to cooperative learning strategy. It implied that the method was equally beneficial to both high and low ability students. This is because it helped to improve their achievement test scores in basic science. Thus, the null hypothesis of non-significant difference was retained.

$H0_4$ There is no significant difference in basic science achievement test scores among students of varying abilities exposed to cooperative learning strategy and those taught with the lecture method.

Table 16 Summary of analysis of Covariance (ANCOVA) for the significance of difference in basic science achievement test scores among students of varying abilities exposed to cooperative learning strategy and those taught with lecture method.

Dependent Variable POST_TEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	212604.102[a]	3	70868.034	2078.963	.000
Intercept	1596791.242	1	1596791.242	46842.989	.000
Scholastic_Ability	132980.660	1	132980.660	3901.081	.000
Instructional_Method	85062.165	1	85062.165	2495.358	.000
Scholastic_Ability * Instructional_Method	2322.730	1	2322.730	68.139	.000
Error	20555.160	603	34.088		
Total	1794471.000	607			
Corrected Total	233159.262	606			

a. R Squared = .912 (Adjusted R Squared = .911)

Figure 2 Graph illustrating significance of difference in basic science achievement test scores among students of varying abilities exposed to cooperative learning strategy and those taught with lecture method.

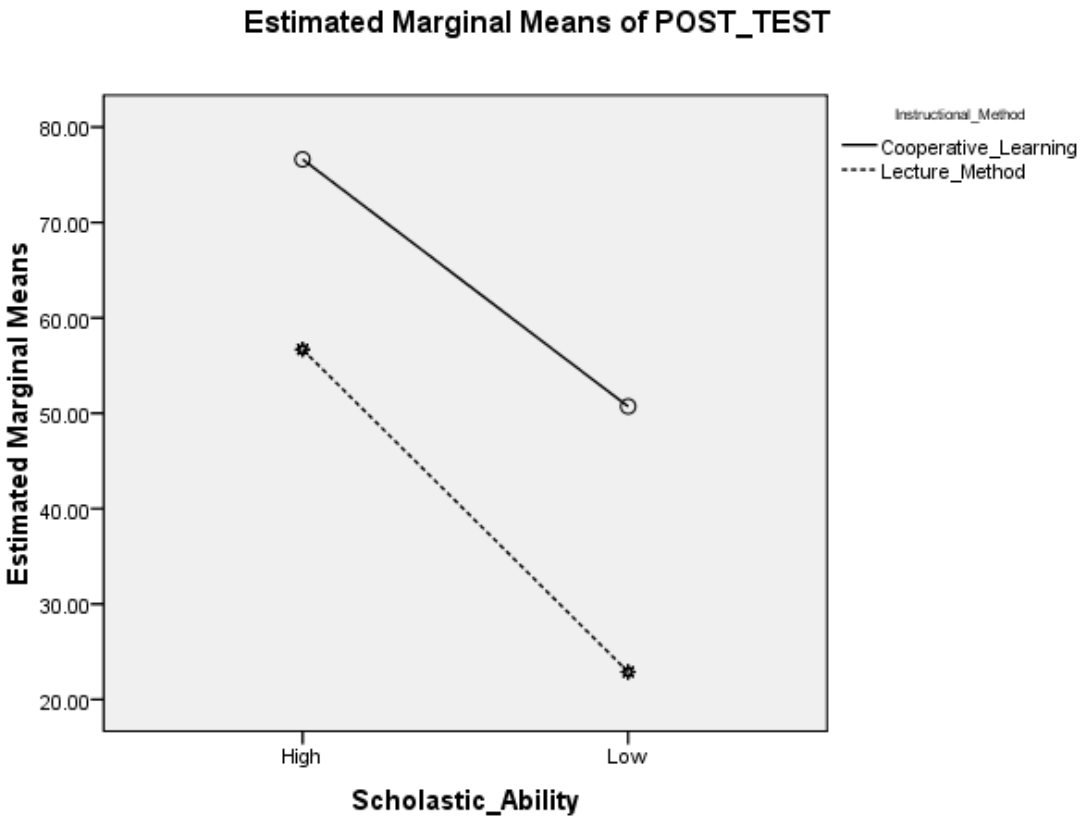


Table 16 with (F(603) = 68.139 P < 0.05) and fig 4.2 indicate that there is significant difference in basic science achievement test scores among students of varying abilities exposed to cooperative learning strategy and those taught with lecture method. This is because the high and low ability students of the cooperative learning strategy

performed better than the high and low ability students of lecture method respectively. Thus, the null hypothesis of non-significant difference was rejected. The graph above is an ordinal interaction graph since there is no crossing of the lines.

$H0_5$: There is no significant difference in basic science achievement test scores between the male and female students taught with lecture method.

Table 17: Summary of Analysis of Covariance (ANCOVA) for the significance of difference in basic science achievement test scores between the male and female students taught with lecture method.

Dependent Variable: POST_TEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	87533.050[a]	3	29177.683	5849.016	.000
Intercept	738.606	1	738.606	148.063	.000
GENDER	124.630	1	124.630	24.984	.000
PRE_TEST	79215.432	1	79215.432	15879.683	.000
GENDER * PRE_TEST	32.065	1	32.065	6.428	.012
Error	1416.727	284	4.988		
Total	520780.000	288			
Corrected Total	88949.778	287			

a. R Squared = .984 (Adjusted R Squared = .984)

Figure 3 Graph illustrating significance of difference for basic science achievement test scores between the male and female students taught with lecture method.

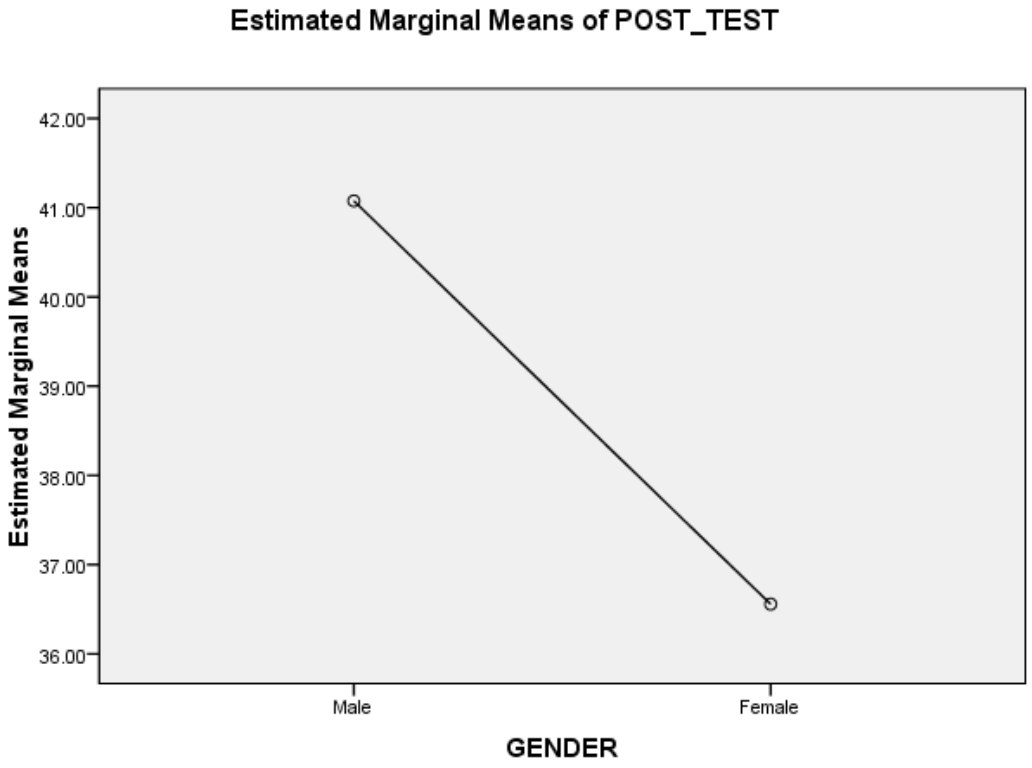


Table 17 (F (284) = 6.428 P<0.05) and fig 3 indicate that there is significant difference in basic science achievement test scores between male and female students taught with lecture method. There is also a difference in the mean gain of male and female students taught with lecture method (12.30 and 6.74) respectively (see Table 8). This implies that using the lecture method, the male students benefitted more than their female counterparts. Thus, the null hypothesis of non-significant difference was rejected.

$H0_6$: There is no significant interaction effect between the method used in teaching the students and their gender on achievement test scores in basic science.

Table 10: (refer. Summary of analysis of covariance for the significant interaction between method of instruction and gender on student achievement test scores in basic science).

Figure 4 Graph illustrating significance of interaction effect between the method used in teaching the students and their gender on achievement test scores in basic science.

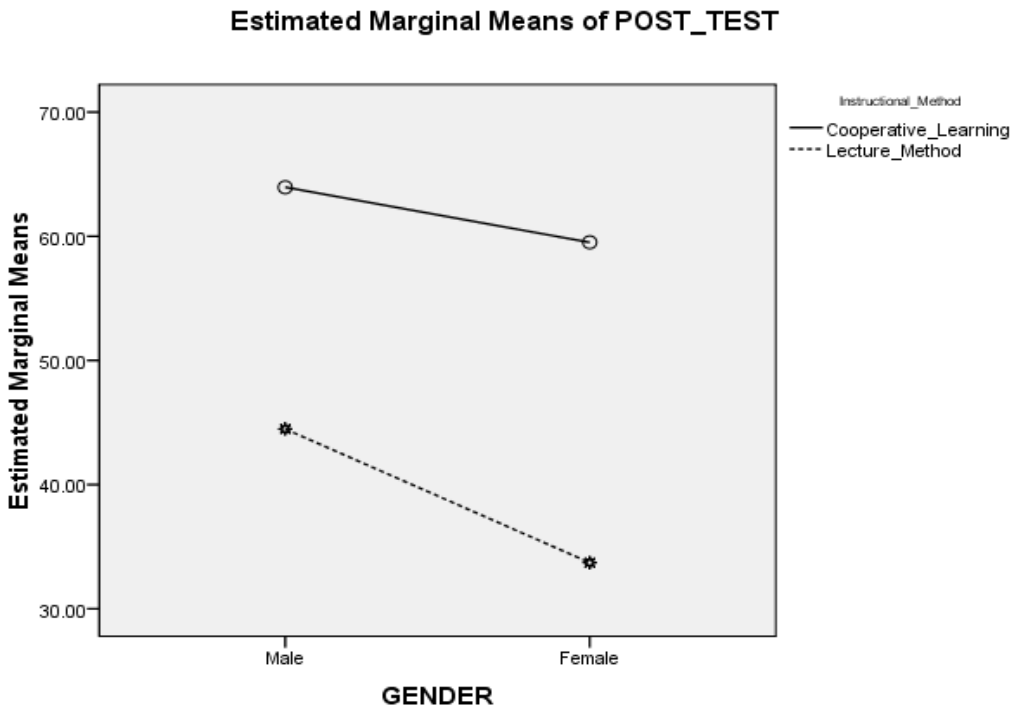


Table 10 (F (603) = 6.502 P< 0.05) and fig 4 indicate that there is significant interaction effect between the method used in teaching students and their gender an achievement test scores in basic science. This implies that

the method interacted with gender to effect the levels of achievement of students in basic science. Thus, the null hypothesis of non-significant interaction effect was rejected. The graph above is an ordinal interaction graph.

$H0_7$: There is no significant interaction effect between the method used in teaching the students and their ability on achievement in basic science.

Table 11 (refer. Summary of analysis of covariance (ANCOVA) for the significant interaction effect between method of instruction and ability on students' achievement in basic science).

Figure 5 Graph illustrating significance of interaction effect between the method used in teaching the students and their ability on achievement test scores in basic science.

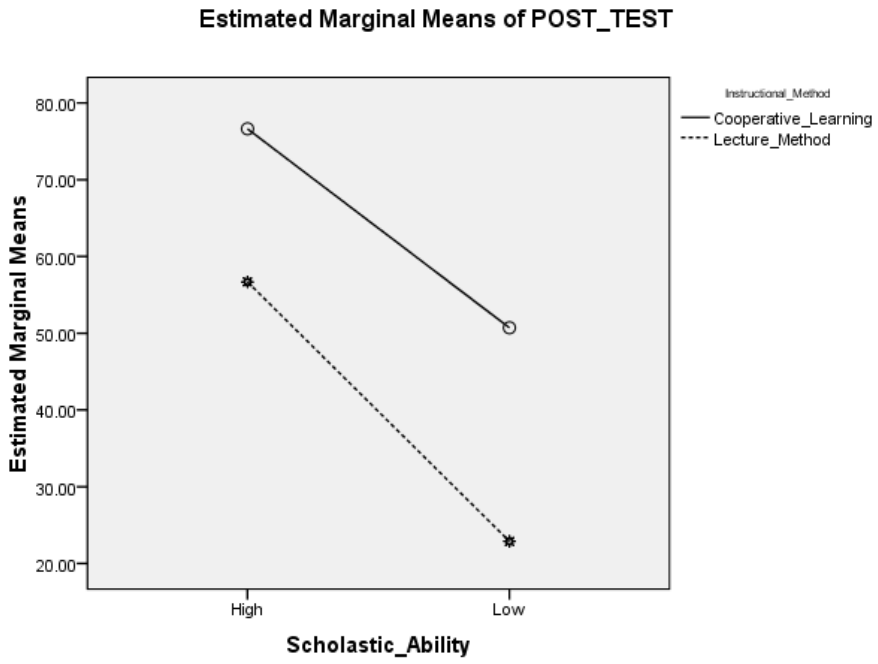


Table 11 (F (603) = 68.139 P < 0.05) and fig 5 above indicate that there is significant interaction effect between the method used in teaching the students and their ability on achievement test-scores in basic science. This implies that the method interacted with the ability of the students to cause the desired achievement test scores in basic science. Thus, the null hypothesis of non-significant interaction effect was rejected.

$H0_8$: There is no significant interaction effect between the gender of the students and their ability on achievement test scores in basic science .

Table 18: Summary of Analysis of covariance (ANCOVA) for the significant interaction effect between the gender of the students and their ability on achievement test scores in basic science.

Dependent Variable:POST_TEST

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	Hypothesis	1611660.057	1	1611660.057	13.983	.166	.933
	Error	115260.225	1	115260.225[a]			
GENDER	Hypothesis	2177.495	1	2177.495	8.619	.209	.896
	Error	252.628	1	252.628[b]			
Scholastic_Ability	Hypothesis	115260.225	1	115260.225	456.245	.030	.998
	Error	252.628	1	252.628[b]			
GENDER * Scholastic_Ability	Hypothesis	252.628	1	252.628	1.387	.239	.002
	Error	109799.126	603	182.088[c]			

a. MS(Scholastic_Ability)

b. MS(GENDER * Scholastic_Ability)

c. MS(Error)

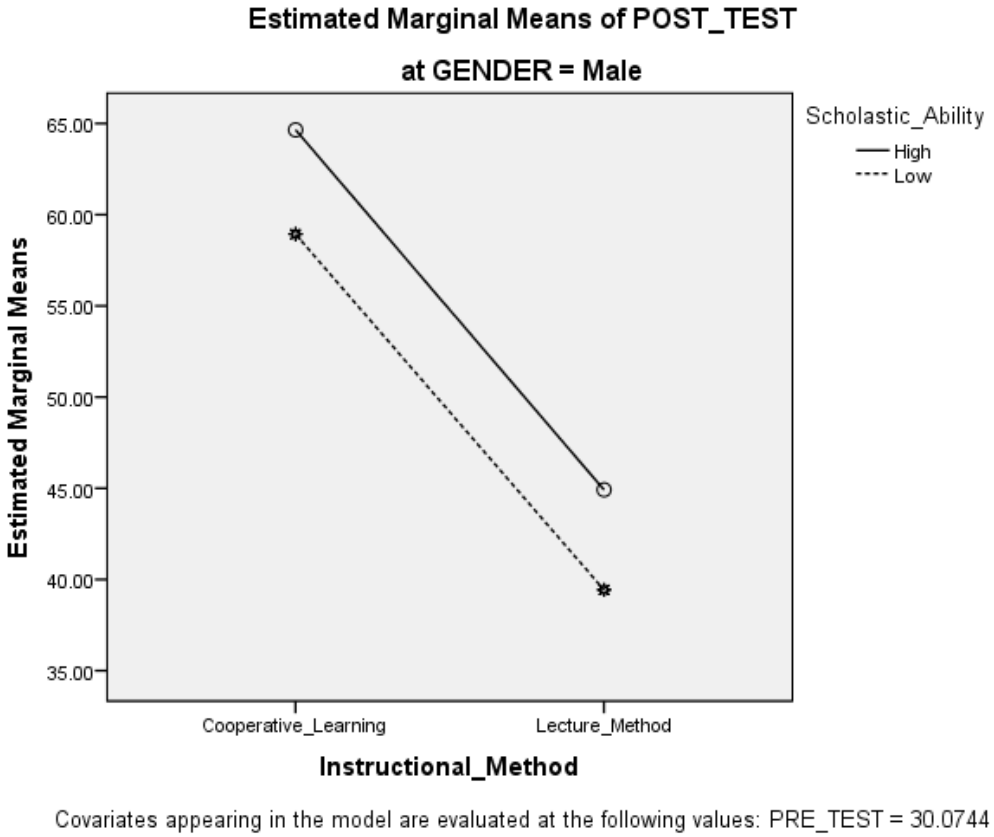
Table 18 ($F(603) = 1.387$ $P > 0.5$) indicates that there is no significant interaction effect between gender of the students and their ability on achievement test scores in basic science. This implies that gender and ability of the students did not jointly cause the desired achievement test scores in basic science. Thus, the null hypothesis of non-significant interaction between the gender and ability of the students on the achievement test scores in basic science was retained.

$H0_9$: There is no significant interaction effect among methods, gender and ability of the students on achievement test scores in basic science.

Table 12: (refer. Summary of analysis of covariance (ANCOVA) for the significant interaction among method of instruction, gender and ability on students' achievement test scores in basic science).

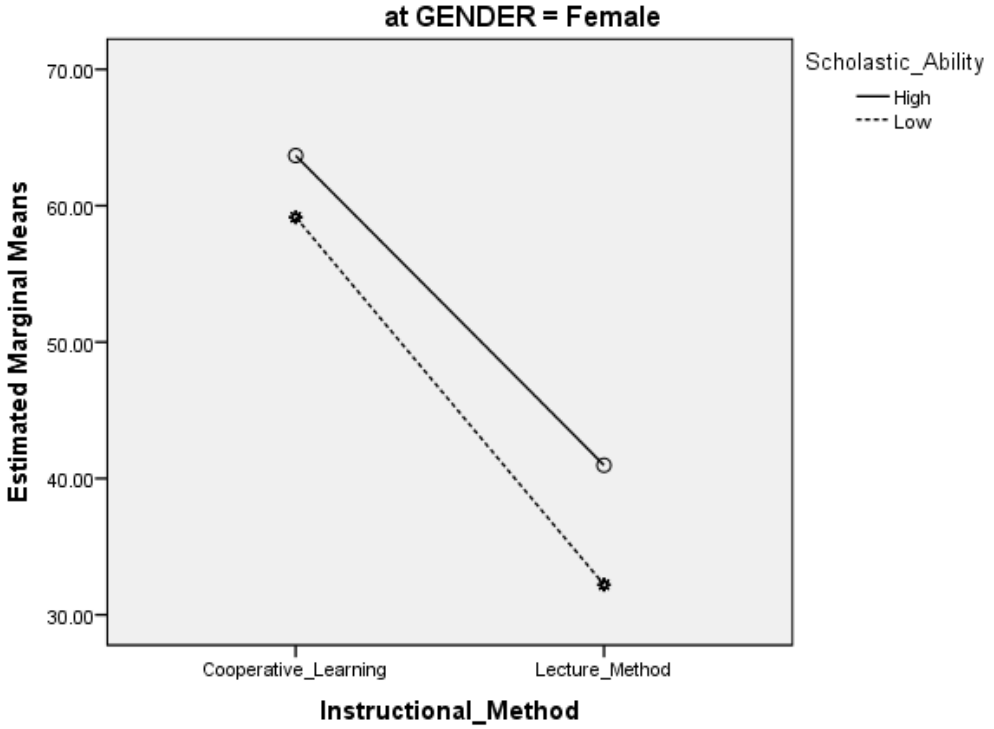
Figures 6 to 11: Graphs illustrating significant of interaction effect among method, gender and ability on students' achievement test scores in basic science.

Figure 6 Instructional_ Method * Scholastic_ Ability * GENDER



The above graph is an ordinal interaction graph.

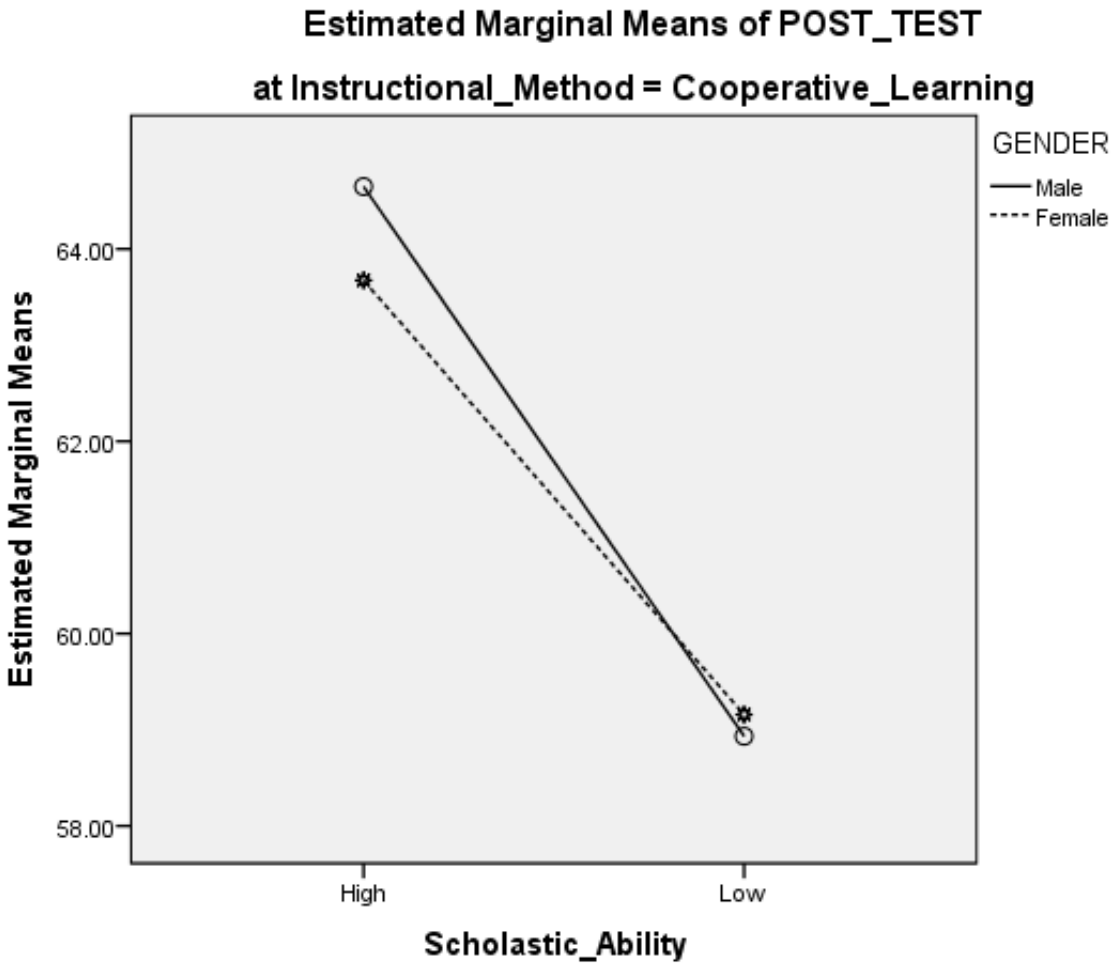
Figure 7 Estimated Marginal Means of POST_TEST



Covariates appearing in the model are evaluated at the following values: PRE_TEST = 30.0744

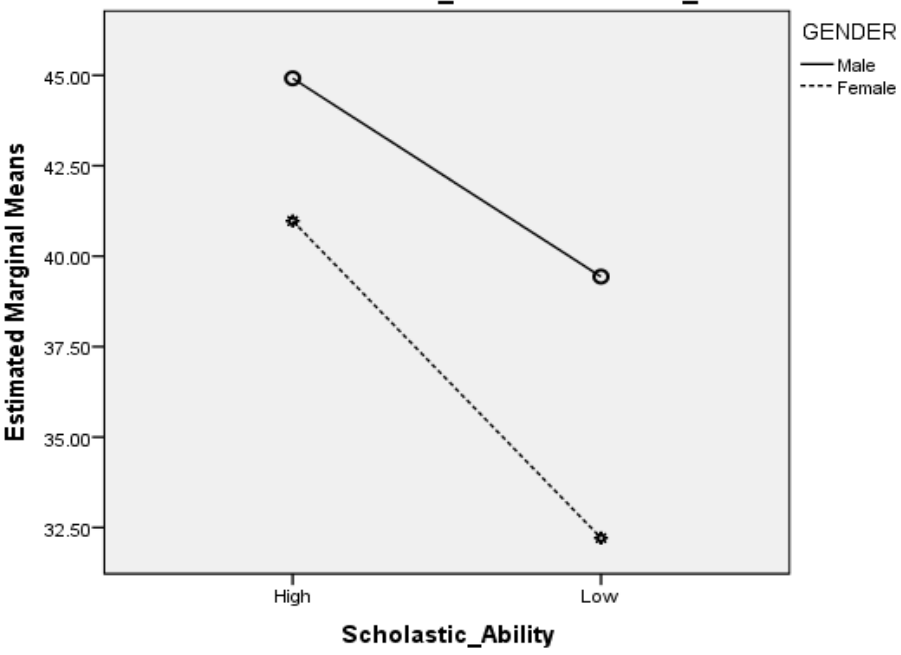
The above graph is an ordinal interaction graph.

Figure 8 Scholastic_Ability * GENDER * Instructional_Method



The graph above is a disordinal interaction graph because there is crossing of the lines.

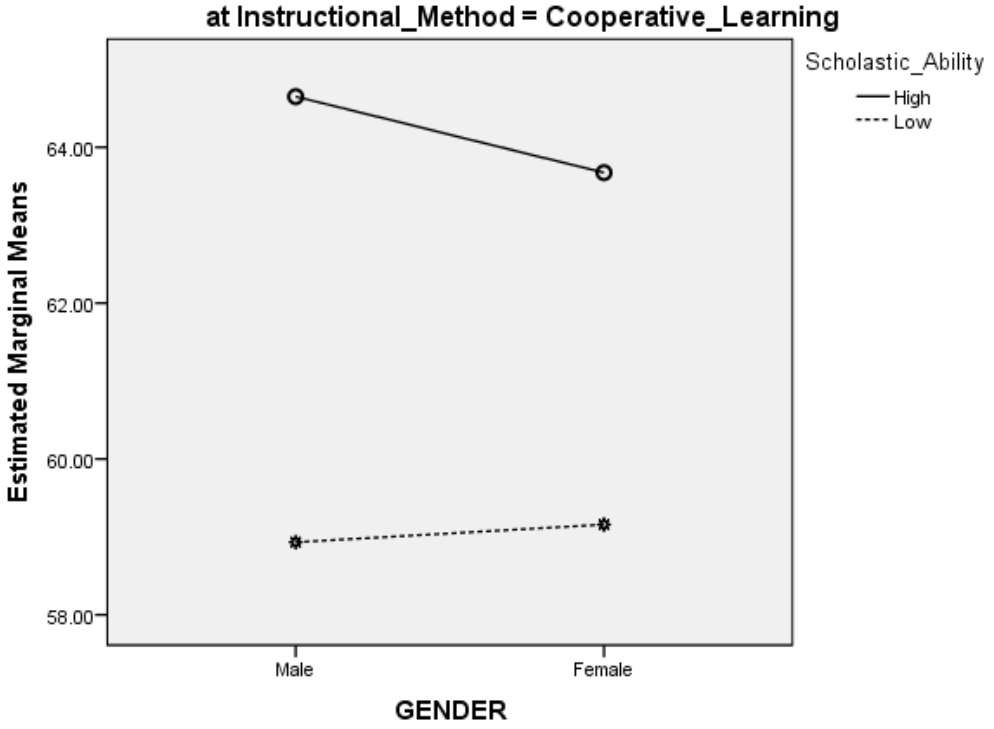
Figure 9 Estimated Marginal Means of POST_TEST at Instructional_Method = Lecture_Method



Covariates appearing in the model are evaluated at the following values: PRE_TEST = 30.0744

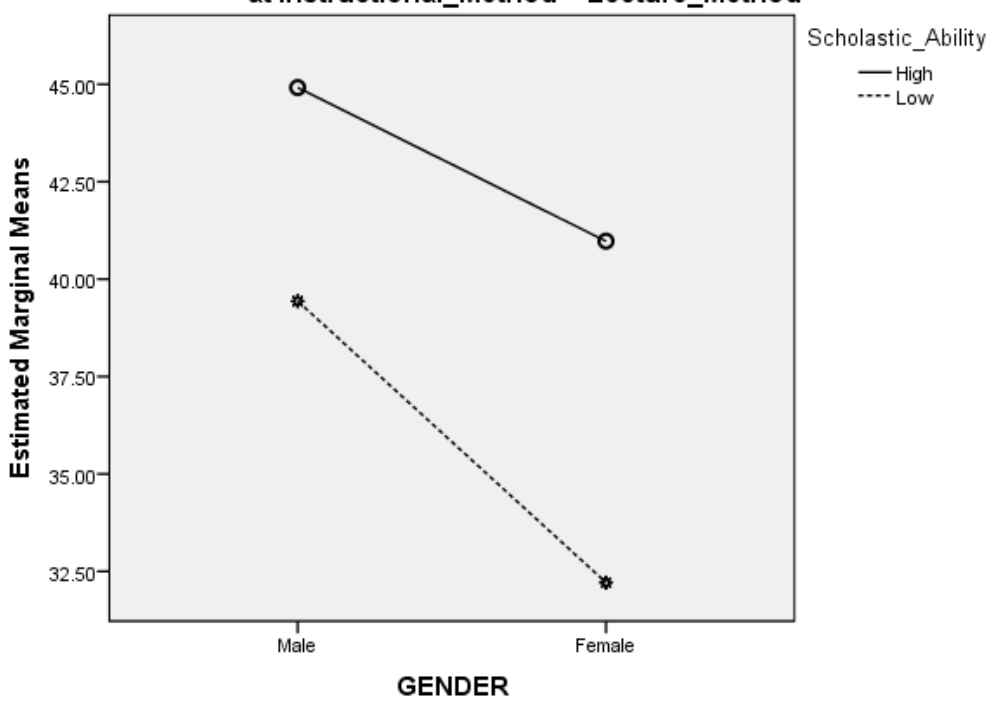
The above graph is an ordinal interaction graph.

Figure 10 Estimated Marginal Means of POST_TEST



The above graph is an ordinal interaction graph.

Figure 11 Estimated Marginal Means of POST_TEST at Instructional_Method = Lecture_Method



Covariates appearing in the model are evaluated at the following values: PRE_TEST = 30.0744

The above graph is an ordinal interaction graph.

Table 12 with (F(593) = 78.725 P < 0.05) and figures 6 to 11 indicate that there is significant interaction effect among method of instruction used, gender and ability on students' achievement test scores in basic science. This implies that the three factors interacted to cause the desired achievement test scores of the students in basic science. Thus, the null hypothesis of non-significant interaction effect was rejected.

Discussion of Results

The study sought to determine the effects of cooperative learning style on students' achievement in basic science. The study also examined the extent to which ability and gender affected students' achievement in cooperative learning class when compared with the lecture method class.

Table 4 shows an improved performance in the achievement of students which indicates that cooperative learning and lecture method were effective in enhancing students' achievement as shown in the mean gain. The cooperative learning class students performed significantly better than their counterparts in the control group. This corroborates the findings of Adeyemi (2002), who stated that students that were instructed with cooperative learning style performed significantly better than students taught with the lecture method.

The reason for this superior performance may be related to the nature of the instructional strategy employed. In this strategy emphasis was placed on the learner rather than the teacher. The learners interacted with objects, learning materials, and thereby gained an understanding of the concepts. All the students in the cooperative group performed specific roles in solving problems, which was presented in the classroom to the benefit of all members of the group. When learners are

confronted with problems, which they must solve, they are forced to reason and think critically in order to solve the problems. Active participation and engagement is said to enhance understanding, hence improved achievement (Ablard and Lipschultz, 1998).

The cooperative learning style was more effective than the lecture method in enhancing students' achievement in basic science. This finding corroborates the findings of Okebukola (1984), Slavin (1990), Mulryan (1995), Alebiosu (1998), Zisk (1998), Esan (1999), Ifamuyiuwa (2001), Adeyemi (2002), Ojo (2003), Oludipe (2003), Omosehin (2003) and Ejike (2006). An explanation for the superior performance could be found in the words of Ejike (2006). The researcher noted that in a classroom setting, students are heterogeneous with respect to their ability when they work together in a group setting and deliberate intervention by more capable peers can assist weak learners by providing a scaffold for them to build on their existing knowledge and experience.

This finding also agrees with the findings of Stevens and Slavin (1995); Lampe, Rooze and Talent- Runnels (1998), and Borich (2004). It is believed that when properly and carefully used, cooperative learning activities engage the students in learning process and seek to improve the critical thinking, reasoning and problem-solving skill of learners (Bramlett, 1994; Megnin, 1995; Webbs, Tropper

and Fall, 1995). According to Bramlett (1994), Megnin (1995), Webb et al (1995) and Ajaja and Eravwoke (2010), active engagement of students and critical thinking, students' memory and creativity constructive activity and collaborated learning are enhanced in cooperative learning classroom which result to improved performance of students. This finding, however, does not agree with Koster (1990), who reported that cooperative learning style does not enhance students performance.

The result of this study shows that gender had no significant effects on students' achievement in a cooperative learning class, but had significant effects in the control group. This is because, as shown in Table 8, the male had higher mean gain than their female counterparts in lecture method class. The finding of this study corroborates the findings of Okebukola (1985), Peterson, Johnson and Johnson, (1991), Garduno (2001), Cirila (2003), Wachanga and Mwangi (2004), Ajaja and Eravwoke (2010), Olatoye and Adekoya (2011), Muraya and Kimamo (2011) and Olatoye et al (2011). They stated that all students irrespective of their sexes benefited in about the same margin from the use of cooperative learning strategy. This finding is in contrast with the findings of Humphrey, Johnson and Johnson (1982), Webbs (1982, 1989), Adeyemi (2003), Akinbobola (2006) and Kolawole

(2007), who stated that males performed significantly better than their female counterparts.

The result of the study shows that the abilities of students exposed to cooperative learning strategy did not create any significant difference in their mean gain, that is between the high and low ability students as shown in table 4.3. This corroborates the findings of Ajaja and Eravwoke (2010), Olatoye and Adekoya (2010) and Olatoye et al (2011). However, there was observed significant difference in the mean gain (magnitude of benefit) between the high and low ability students taught with lecture method (see Tables 7 and 9).

The performance of students in cooperative learning class is achieved because, according to Aronson (2002), group members must work together as a team to accomplish a common goal and each person depends on one another. No student can achieve his or her individual goal of learning the material or getting a good grade unless everyone work together as a team. This corroborates the findings of Robinson (1990), Allan (1991), Webbs (1982) and Ajaja and Eravwoke (2010) who stated that in a well-structured cooperative learning class both high and low ability students benefit equally. This is in contrast to the findings of Abimbade (1990), Watson (1991) and Pepple (2010) who observed that the high ability students

performed better than the low ability students in a cooperative learning class.

The finding in hypothesis five stated that there was significant difference found in the achievement test scores between the male and female students taught with lecture method. The finding corroborates with the results of Kelly (1987), Scoffled (1994), Erinosho (1995), Yoloye (1998), Jones (1999), Postlethwaist and Wiley, (1999), Andre (2001) and Kotte (2002), but this contradicts the findings of Iroegbu (2000) and Ige (2008) who found no significant main effect of gender on students' achievement in a lecture method.

The study showed significant interaction effect between method and gender; method and ability, and among method, gender and ability. Corroborating these findings are the works of Webbs (1980, 1982 and 1989), Swing and Peterson (1982), Webbs and Cullian (1983), Oyedeji (1991), O'donnel and Dansereau (1992), Okebukola (1992), Slavin (1995), Iroegbu (2004), Barrett (2000), Salami (2000), Aremu (2001). Contradicting these findings are the works of Okebukola (1985), Garduno (2001), Ajaja and Eravwoke (2010), Olatoye and Adekoya (2010) and Olatoye et al (2011); who stated that there was no significant interaction effect between method and gender, method and ability, and among method, gender

and ability. That the effect of the treatment was not dependent on the two factors (gender and ability).

The researcher believes that the ages of the learners and the duration of the treatment may be the factors resulting in the disagreement of some of the findings noted by this study.

The finding of this study shows that there was no significant interaction effect between the gender and ability on the achievement test scores of the students in basic science; which was stated in hypothesis eight. This corroborates the findings of Ajaja and Eravwoke (2010), Olatoye and Adekoya (2010) and Olatoye et al (2011). Contradicting this finding are the works of Erinosho (1995), Jones (1999) Andre (2001) and Kotte (2002) who found significant interaction effect between the two variables (gender and ability). This according to the researcher of this study implies that the students' ability is not dependent on the gender to influence the achievement of students in basic science. That is to say, a student with a particular ability as far as he or she is actively engaged in the collaborative skills involved in cooperative learning class, will influence the learning material and knowledge content irrespective of his or her gender.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter gives a summary of the research, conclusion, recommendations, as well as appropriate suggestion for further research.

Summary of the Research

This study was carried out in the three senatorial districts of Rivers State to investigate the effects of cooperative learning strategy on students' achievement in basic science. Three research instruments were used for the study. These are:

1. Scholastic Ability Test in Basic Science (SATBS)
2. Basic Science Achievement Test (BSAT).
3. Cooperative Learning Manual or Intervention

The sample was made up of six hundred and seven (607) UBE-9 (JSS3) students from six government- owned secondary schools selected by simple balloting technique. The research design was a 2x2x2 non-randomized pre-test, post-test control group quasi-experimental design. The instruments were valida ted and their reliability co-efficient determined before they were used. The data collected were subjected to ANCOVA. The six secondary schools of UBE-9 selected were co-educational institutions, having not les than two arms of UBE-9. The samples used were of intact class. One of the arms of the UBE-9 of the sampled

schools served as the experimental group, while the other served as the control group. Six null hypotheses were rejected and three null hypotheses retained. The study showed significant effect of cooperative learning strategy by improving the performance of students achievement in basic science. There were also significant interaction effect between method and ability, method and gender, and among method, gender and ability. Though, there was no significant interaction effect between gender and ability found.

Summary of Findings

Analysis of data revealed the following findings.

1. students in the cooperative learning group performed significantly better than students in the lecture method group.
2. there was no significant difference between the achievement of male and female students in the cooperative learning group.
3. there was no significant difference between the achievement of high and low ability students in the cooperative learning group.
4. the varying ability students of the cooperative learning group performed significantly better than their varying ability counterpart in the control group (lecture method).

5. The high ability students in the lecture method group performed significantly better than the low ability students in the lecture method group.
6. there is an interaction effect between the method used in teaching the students and their gender on achievement test scores in basic science.
7. there was also interaction effect between the method used in teaching the students and their ability on achievement test-scores in basic science.
8. there was no significant interaction effect between gender of the students and their ability on achievement test scores in basic science.
9. finally, methods, gender and ability of the students significantly exhibited interaction effect on the achievement of the students in basic science.

Conclusion

Result from the findings indicated that cooperative learning as investigated in the study with strong empirical support for it and the fact that it makes sense for students' achievement, is a very viable option among other instructional methods for teaching science in secondary schools.

Secondly, since there was significant interaction effects among methods, gender and ability on students' achievement in basic science; it can be concluded that if

the right instructional method is combined with the students' gender and ability, the students will achieve better in basic science.

Thirdly, the finding indicated that the high and low ability students benefited equally in magnitude, it then suggested that cooperative learning strategy is a more suitable instructional approach that will improve the achievement of the high and low ability students.

Fourthly, there was no significant difference in achievement between the male and female students engaged in the cooperative learning group, indicated that this instructional method was not gender biased. This will have positive effect on male and female students and thus encourage gender equity in science achievement especially basic science.

Contribution to Knowledge

This study has contributed to knowledge in the following ways:

1. that the use of cooperative learning strategy in teaching basic science enhances students' understanding of basic science since they work in heterogeneous groups;
2. the frontiers of active teaching learning approaches have been expanded with the inclusion of the cooperative learning approach to teaching basic science; and

3. achievement of students in basic science using the cooperative learning approach is not influenced by students' gender and ability levels.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. the findings from this study have proved the efficacy of cooperative learning approach in enhancing higher academic achievement in basic science. Therefore, basic science and science teachers in general are encouraged to use cooperative learning approach as a way of improving their students' achievement in the subject. That is to say that they should expose the students to cooperative learning method to encourage social interaction among learners.
2. workshops should be organized for science teachers to emphasis the use of cooperative learning.
3. Textbook writers should shift emphasis from teachers' activities to students' activities that will promote cooperative learning in their basic science textbooks.
4. Curriculum planners should ensure that curriculum implementation put into practice the use of cooperative learning strategy. For wider application

of this approach, some policy guidelines should be formulated to guide the implementation process. In particular, teachers would require training and reference materials on how to implement the cooperative learning approach.

5. Policy makers in education should formulate policy guidelines on modalities of training teachers through pre-service and in-service teacher training programmes on cooperative learning approach. Such policy guidelines should be geared towards implementation of cooperative learning approach.
6. The heads of education institutions should supervise the implementation of the cooperative learning method in their institutions.

Suggestions for Further Research

(1) This study should be replicated in other states of Nigeria using both public and private schools, more sample sizes, and longer period of treatment.

(2) The study should also be replicated at the primary and senior secondary levels of education.

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APPENDIX I
SCHOLASTIC ABILITY TEST IN BASIC SCIENCE
(SATBS)

NAME OF STUDENT:

NAME OF SCHOOL:

SEX:

Introduction: Each question is followed by five options lettered A-E. choose the correct answer that best fits the question.

1. An organism is said to be _____ when its is able to manufacture its own food

A. Abiotic

B. Autotrophic

C. Sapnophytic

D. Parasitic

E. Symbiotic

2. $6C0_2 + 6H_20 \Rightarrow C_6H_{12}0_6 + 60_2$. The process that is directly opposite the chemical equation represented above is

A. Decay

B. Digestion

C. Excretion

D. Respiration

E. Reproduction

3. One example of wood crop is

A. Groundnut

B. Guava

C. Mahogany

D. Maize

E. Mango

4. Which of the following statement is NOT true of the solid state of matter?

A. It has a fixed shape

B. It has a fixed volume

C. Particles are arranged in a regular pattern.

D. Particles are free to more about

E. Particles are held very close to each other.

5. Substances burn in air to produce.

A. Chlorine

B. Hydroxides

C. Oxides

D. Sulphides

E. Sulphates

6. Which of the following is NOT true of rusting?

A. An oxide of iron is formed

B. Can be prevented by greasing

C. Heat energy is released

D. Occurs in dry air

E. Reduces the quality of iron

7. Heat quantity is measured in what unit?

A. Amperes

B. Joules

C. New tons

D. Volts

E. Watts.

8 Which of these devise can be used to prove that light energy does work.

A. Biconvex lens

B. Dynamo

C. Electric Motor

D. Photoelectric Cell

E. Thermocouple

9. Steel is used to make all the following except

A. As material to mould blocks

B. Building bridges

C. To reinforce concretes

D. Making armoured plates

E. Making crushing mach

10. A salt like $CUS0_4 5H_2 0$ which contains water of crystallization is said to be.

A. Anhydrous

B. Double

C. Hydrated

D. Mixed

E. Non-crystalline

11. The process by which heat energy is transferred by the movement of the heated substance itself is called

A. Conduction

B. Convention
C. Radiation
D. Evaporation
E. Transmission

12. All the following are true of polluted water except that
A. Decay takes place readily in it
B. The amount of nitrates and phosphates is increased.
C. The amount of oxygen is greatly reduced
D. The population of algal is increased
E. The water has a pleasant smell.

13. Which of the following is not useful in classifying objects?
A. Size
B. Time
C. Weight
D. Colour
E. Texture.

14. The following situations ensure a healthy home environment except
A. Burning mosquito coils in the room at night
B. Boiling and filtering drinking water
C. Having rooms with windows opposite to one another
D. Keeping refuse in close dust bins
E. Flushing the toilet after every use

15. Which of these activities does Not belong to the group?

A. Adapting
B. Flying
C. Swimming
D. Crawling
E. Dispersing

16. Which of the following is an example of a solid?

A. Ink
B. Oil
C. Pap
D. Mercury
E. Sand

17. The three states of matter are.

A. Solid, water and gas
B. Vapours, solids and gases
C. Solids, liquids and gases
D. Protons, neutrons and electrons
E. Ice, Water, Steam.

18. The cation mainly responsible for hardness of water is

A. Na^{+}
B. Ca^{2+}
C. Mg^{2+}
D. K^{+}
E. Al^{3+}

19. Which of these activities best illustrates the concept of force?

A. Reading a book

B. Moving a box

C. Sleeping on a bed

D. Sitting on a chair

E. Observing the sky

20. Which of the following is Not a water born disease?

A. Dysentery

B. Tetanus

C. Cholera

D. Diarrhea

E. Typhoid

21. The best way to dispose the faeces in the city is to use the _____ type of toilet.

A. Pit

B. Flush

C. Bucket

D. Riverside

E. Bush

22. The disease in which the production of white blood cell is greatly increased by over exposure to x-rays is termed.

A. Anemia

B. Leukemia

C. Sickle Cell

D. Polio

E. Tetanus

23. Food is digested by the chemical action of

A. Peristalsis

B. Enzymes

C. Saliva

D. Churning

E. Hormones

24. Hands, arms, shoulder, pelvis, thing legs and feed are collectively referred to as.

A. Bones

B. Vertebrates

C. Appendages

D. The trunk

E. The skeletal system

25. What is the SI unit of measurement of density?

A. J

B. Nm

C. Nm^{-3}

D. Gm^{-3}

E. Kgm^{-3}

26. Which of the following is an abiotic factor?

A. Termite

B. Soil

C. Grass

D. Ant

E. Grasshopper

27. The arrangement of elements in the order of the ease with which they combine with oxygen is called_____ series

A. Combustion

B. Activity

C. Parellel

D. Reduction

E. Electron

28. The following are products of the destructive distillation of coal EXCEPT

A. Coal gas

B. Light oil

C. Coal tar

D. Coke

E. Diesel oil

29. Which of these elements will MOST EASILY burn in oxygen?

A. Copper

B. Platinum

C. Gold

D. Magnesium

E. Silver

30. The pinhole camera operates on the basis that

A. Objects are luminescent

B. Images are translucent

C. Light is a ware energy

D. Light is reflected

E. Light travels in straight lines.

31. The smallest particles of a substance which can take part in a chemical reaction is called

A. Atom

B. Molecule

C. Electron

D. Compound

E. Element

32. Which of these statements is NOT true about sound. Sound. Sound

A. is a wave motion

B. can travel through a vacuum

C. can be reflected

D. can be focused

E. is caused by a vibrating body

33. If an element X with a combining power with a combing power of 3 the formula of the compound formed would be written as

A. B_2X_3

B. B_3X_2

C. $2BX_3$

D. $3BX_2$

E. $2B_3X$

34. A ball of mass 12g of a height of 4m is released and falls freely restically downwards to touch the ground.

Calculate the work down by the ball in falling through the height.

A. 48J

B. 4.8J

C. 3.0J

D. 0.48J

E. 0.048J

35. The sign of lightening is always observed before that of thunder because;

A. Lightening is an electrical discharge

B. Light is brighter than sound

C. Light travels faster than sound

D. Lightening has electrical energy while thunder has sound energy

E. Lightening is made up of both light and sound.

36. Which of the following activities can cause reduction in forests?

A. Establishment of forest reserve

B. Tree planting campaign

C. Use of petroleum products as alternatives firewood

D. Uncontrolled felling of tree

E. Establishment of nurseries to produce tree seedlings.

37. An animal with very well developed canine teeth is likely to normally feed on

A. Nuts

B. Grass

C. Insects

D. Meat

E. Bones

38. How would you separate a mixture of salt and sand?

A. Dissolve in alcohol and distil fractionally

B. Dissolve in alcohol, filter and dry

C. Dissolve in water and filter

D. Dissolve in water, filter and evaporate for dryness.

E. Heat the mixture and filter.

39. The members of the nuclear family are the

A. Father and his children

B. Father, mother and their children

C. Father, mother, their children and in-law

D. Mother and her children

E. Parents, their children and grand children.

40. The enzyme that converts starch to maltose in the month is called

A. Erepsin

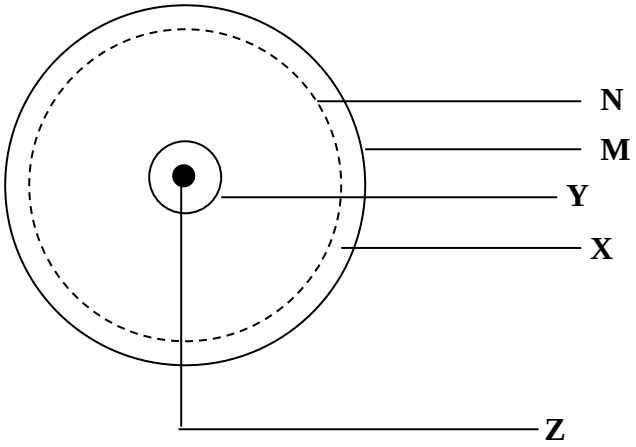
B. Maltase

C. Ptyalin

D. Steapsin

E. Trypsin

41. Which of the part labeled (M-Z) in the diagram below represents the nucleus



A. N

B. M

C. Y

D. X

E. Z

42. The following are all functions of the bone EXCEPT

A. Acting as levers

B. Giving animals shape

C. Helping animals in movement

D. Protecting delicate organs

E. Supplying liquids to the body

43. The simplest way to test for glucose is to use_____ solution.

A. Ethanol

B. Fehling's solution

C. Iodine

D. Methylated spirit

E. Millions reagent

44. For seeds to germinate it needs

A. Air, water and warmth

B. Nitrogen, soil and oxygen

C. Oxygen, carbon (iv) oxide and water

D. Oxygen, soil and warmth

E. Water, soil and warmth

45. All the following are methods of vegetative propagation EXCEPT

A. Budding

B. Cutting

C. Grafting

D. Layering

E. Seeding

46. The interval between laying of eggs and hatching of chicks is called _____ period.

A. Breeding

B. Candling

C. Incubation

D. Rearing

E. Resting

47. Which of these groups of waste products are excreted from the kidney?

A. Carbon (iv) oxide, water, salt

B. Water, carbon (iv) oxide, and water

C. Water, carbon (iv) oxide, salt

D. Water, Urea, salt

E. Oxygen, water and salt.

48. The process of replanting trees to replace those out is called?

A. Afforestation
B. Deforestation
C. Desertification
D. Plantation
E. Rejuvenation

49. Lines drawn across a map connecting points of equal barometric pressure are called.

A. Barometers
B. Isobars
C. Isogals
D. Isohyets
E. Isotherms.

50. A man of mass 90kg has kinetic energy of 2205J. Calculate his velocity.

A. 5m/sec
B. 7m/sec
C. 10m/sec
D. 15m/sec
E. 18m/sec.

APPENDIX II
BASIC SCIENCE ACHIEVEMENT TEST (BSAT)

Name of student:----------
Name of school:----------

Sex of student:----------

Type of instruction:----------

Instruction Each question is followed by five options lettered A-E. Choose the correct answer that best fits the question.

1. Which of the following is NOT found in the plant cell?

A. Cytoplasm
B. Glyeogen
C. Mitochondrion
D. Nucleus
E. Vacuole

2. What method would you use to separate a mixture of Ammonium chloride and sodium chloride?

A. Chromatography
B. Decantation
C. Filtration
D. Magnetization
E. Sublimation

3. The unit of force is

A. Centimeter
B. Gramme
C. Joule
D. Meter
E. Newton

4. Which of the following animals is NOT multicellular?

A. Amoeba

B. Lizard

C. Millipede

D. Parrot

E. Snail

5. The following are invertebrates EXCEPT

A. Centipede

B. Earthworm

C. Millipede

D. Mouse

E. Octopus

6. Which of the following substances is a compound?

A. Carbon

B. Hydrogen

C. Oxygen

D. Water

E. Zinc

7. The sum of the protons and neutrons in the nucleus of an atoms is called _____

A. Atomic number

B. Electronic number

C. Mass number

D. Molecular number

E. Nuclear number

8. The mechanical advantage of a machine is 0.4 what is the load on it when an effort of 160N is applied?

A. 640N

B. 400N

C. 64N

D. 40N

E. 6.4N

9. The following tool are used by Auto-mechanics EXCEPT the _____

A. Clipper

B. Jack

C. Plier

D. Screwdriver

E. Spanner

10. Which of the follow is a water-borne disease?

A. Jaundice

B. Malaria

C. Tuberculosis

D. Typhoid

E. Whooping cough

11. The loss or gain of an electron by an atom produces a/an _____

A. Compound

B. Element

C. Ion

D. Molecule

E. Proton

12. An example of a substance that forms colloidal solution in water is _____

A. Dye

B. Palm oil

C. Salt

D. Starch

E. Sugar

13. Which of the following fruits can be dispersed by mechanical explosion?

A. Cashew

B. Bean

C. Mango

D. Millet

E. Tridax

14. Exchange of materials between blood and body cells occurs through the _____

A. Arteries

B. Capillaries

C. Villi

D. Lungs

E. Veins

15. An organism is said to be _____ when it feeds on dead plants and animals

A. Autotrophic

B. Carnivorous

C. Parasitic

D. Saprophytic

E. Symbiotic

16. Different organisms living together in the same habitat make up the.

A. Biosphere

B. Community

C. Niche

D. Ecosystem

E. Population

17. Steel is an alloy of

A. Calcium and tin

B. Carbon and iron

C. Carbon and lead

D. Iron and calcium

E. Tin and iron

18. In which of the following appliances is electrical energy converted to sound energy?

A. Boiling ring

B. Bulb

C. Radio

D. Cooker

E. Pressing iron

19. Stemens are collectively called_____

A. Androecium

B. Carpel

C. Gynoecium

D. Pistil

E. Sepals

20. Tin ore is a mineral mined at_____

A. Aladja

B. Ibadan

C. Jos

D. Kaduna

E. Osogbo

21. A molecule of calcium trioxocarbonate (iv) contains _____ atoms.

A. 5

B. 4

C. 3

D. 2

E 1

22. Which of the following is an insulator?

A. Alumunium

B. Copper

C. Iron

D. Plastic

E. Water

23. In Agro-Forestry, trees and _____ are grown on the same piece of land.

A. Cattle

B. Crops

C. Grasses

D. Goats

E. Poultry

24. Which of these substances can cause temporary hardness of water?

A. Calcium hydrogen txioxocarbonate (iv)

B. Calcium textraoxocarbonate (vi)

C. Calcium textraoxocarbonate (iv)

D. Sodium hydrogen trioxocarbonate (iv)

E. Sodium trioxocarbonate (iv)

25. The SI unit of pressure is _____

A. Kgm

B. Kgm^{-2}

C. Nm

D. Mm^{-1}

E. Nm^{-2}

26. Which of the following is NOT a human blood group?

A. O

B. C

C. B

D. AB

E. A

27 The chemical symbol of mercury is _____

A. Ca

B. Hg

C. Mg

D. Mn

E Ne

28 Egg, meat, fish, milk and beams are examples of _____

A. Carbohydrates

B. Fats and oil

C. Minerals salts

D. Proteins

E. Vitamins

29. A safety device used in electrical appliances is a/an_____

A. Ammeter

B. Fuse

C. Lamp

D. Switch

E. Voltmeter

30 Body substances which can destroy disease causing organisms are called _____

A. Antibacterial agent

B. Antibodies

C. Antigens

D. Antitoxins

E. Antiviral germs

31. Which of the following metals is the most electropositive?

A. Calcium

B. Copper

C. Lead

D. Silver

E. Tin

32. Which of the following gases rekindles a glowing splint?

A. Ammonia

B. Chlorine

C. Hydrogen

D. Nitrogen

E. Oxygen

33. A constellation is made up of _____

A. A group of planets

B. A group of stars

C. The earth

D. The moon

E. The sun

34. Which of the following is NOT a way of caring for growing plants?”

A. Harvesting

B. Manuring

C. Mulching

D. Prunning

E. Watering

35 The particle with the smallest mass is the _____

A. Atom

B. Electron

C. Neutron

D. Nucleon

E. Proton

36 Which of the following is the richest source of vitamin C?

A. Egg

B. Kidney

C. Liver

D. Orange

E. Sunshine

37 Which one of these abnormalities is NOT genetic?

A. Albinism

B. Colour blindness

C. Haemophilia

D. Leukemia

E. Sickle Cell

38. Which of the following is a translucent object?

A. Asbestors

B. Duster

C. Oily paper

D. Plane glass

E. Wall

39 Deficiency diseases in man are usually caused by _____

A. Bacterial infection

B. Eating cheap food

C. Eating too much sugar

D. Lack of essential vitamins

E. Lack of exercise

40. Which of the following instruments is used for measuring relative humidity?

A. Barometer

B. Hygrometer

C. Photometer

D. Potometer

E. Thermometer

41. The reaction between an acid and a base to form salt and water only is known as_____

A. Acidification

B. Dehydration

C. Hydrolysis

D. Neutralization

E. Titration

42 Which of the following is a cash crop in Nigeria?

A. Beans

B. Cocoa

C. Corn

D. Rice

E. Yam

43. The following are parts of an animal cell EXCEPT

A. Cell membrane

B. Cell wall

C. Cytoplasm

D. Nucleus

E. Vacuole

44. The following resources can be derived from plants EXCEPT

A. Fibre

B. Food

C. Hides

D. Medicine

E. Timber

45 Which of these statements is true of a physical change?

A. A large heat change involved

B. It is a permanent change

C. It is easily reversible

D. It is not easily reversible

E. New substance is always formed.

46. The part of plant where photosynthesis takes place is the.

A. Bark

B. Flower

C. Leaf

D. Pollen

E. Root

47. The following factors are necessary for growth EXCEPT_____

A. Exercise

B. Disease

C. Food

D. Heredity

E. Rest

48. A screw is a type of

A. complex machine

B. gear

C. lever

D. pulley

E. inclined plane

49. A chemical symbol is an abbreviation form of the name of a/an_____

A. Acid

B. Compound

C. Element

D. Mixture

E. Salt.

50. Which of the following is a root crop?

A. Cassava

B. Cocoa

C. Cocoyam

D. Onion

E. Yam

APPENDIX III

RELIABILITY OF BASIC SCIENCE ACHIEVEMENT TEST (BSAT)

Reliability coefficent using Test re-test method: Applying Pearson Product Moment Correlation Coefficient

SN	Test1(X)	Test2(Y)	X^2	Y^2	XY
1	45	50	2025	2500	2250
2	55	55	3025	3025	3025
3	40	55	1600	3025	2200
4	45	50	2025	2500	2250
5	65	70	4225	4900	4550
6	65	45	4225	2025	2925
7	60	70	3600	4900	4200
8	45	65	2025	4225	2925
9	55	55	3025	3025	3025
10	55	55	3025	3025	3025
11	60	60	3600	3600	3600
12	50	50	2500	2500	2500
13	70	70	4900	4900	4900
14	45	45	2025	2025	2025
15	70	70	4900	4900	4900
16	65	60	4225	3600	3900
17	50	65	2500	4225	3250
18	50	50	2500	2500	2500
19	55	55	3025	3025	3025
20	55	55	3025	3025	3025
21	50	50	2500	2500	2500
22	65	65	4225	4225	4225
23	60	60	3600	3600	3600
24	65	65	4225	4225	4225
25	65	65	4225	4225	4225
26	60	60	3600	3600	3600
27	45	45	2025	2025	2025
28	55	50	3025	2500	2750
29	55	55	3025	3025	3025
30	45	45	2025	2025	2025
31	60	60	3600	3600	3600
32	65	65	4225	4225	4225
33	55	55	3025	3025	3025
34	60	60	3600	3600	3600
35	45	45	2025	2025	2025
36	50	55	2500	3025	2750
37	55	55	3025	3025	3025
38	45	45	2025	2025	2025
39	60	60	3600	3600	3600
40	60	60	3600	3600	3600
41	70	70	4900	4900	4900
42	65	65	4225	4225	4225
43	65	65	4225	4225	4225
44	55	55	3025	3025	3025
45	45	45	2025	2025	2025
46	45	45	2025	2025	2025
47	55	55	3025	3025	3025
48	50	55	2500	3025	2750
49	50	50	2500	2500	2500
50	70	70	4900	4900	4900
51	45	45	2025	2025	2025
52	50	50	2500	2500	2500
	2885	2940	163575	169550	165800

N = 52

$\sum X$ = 2885

$\sum Y$ = 2940

$(\sum X)^2$ = 8323225

$(\sum Y)^2$ = 8643600

$N\sum X^2$ = 8505900

$N\sum Y^2$ = 8816600

$N\sum XY$ = 8621600

r = 0.79

Pearson Product Moment Correlation Formula used

$$= \frac{N\sum XY - (\sum X)(\sum Y)}{N\sum X^2 - (\sum X)^2\}\{N\sum Y^2 - (\sum Y)^2\}}$$

APPENDIX IV

COOPERATIVE LEARNING MANUAL

GUIDELINES

1. The members of each group will work as a team and reach a common decision.
2. The achievement of an individual in a group is connected with the achievement of the students in the group.
3. Each group will turn out a single solution.
4. Each member should seek help from the other members of the group towards the attainment of a common goal.
5. Each group will receive a grade that will also be given to each member.
6. Each group will work with the booklets provided.
7. The booklet is broken down into weeks and periods.
8. Each member will study problems for each period and then brainstorm collectively to search out solutions to the problems.
9. A leader to direct discussion and a secretary" to write down the solution should be appointed by each group.
10. Each group is free to make a constitution with the teacher if the need arises.
11. You are to work quietly so as not to disturb the other groups.

12. Do not answer the questions for the next lesson unless you are asked to do so.
13. Submit the solution to the teacher for marking together with the workbook.

Week One

Topics: The concept of heredity, cellular basis of heredity, Dominant and Recessive genes, heredity and Environment, family tree, Nuclear and Extended families; Ante-Natal care, Intra-partum care, Post-Natal Care, child care and protection of the infact.

Objectives

By the end of the lesson, the students should be able to;

1. Explain the terms heredity and genetic traits;
2. Distinguish between dominant and recessive genes;
3. Describe how to trace your family tree;
4. Explain the following terms; ante-natal care, intra-partum care; and post-natal care;
5. State the importance of ante-natal and post-natal care;
6. Describe the process of weaning;
7. State methods of protecting the newborn infant from infaction and disease.

Period 1: The concept of heredity,. Cellular basis of heredity, dominant and recessive genes, heredity and environment and family tree.

Heredity has been defined as the transmission of characteristics from parents to their progeny or offspring. Thus, tall parents often have tall children. There are other characteristics that are transmitted by the parents to their children such as size of eyes, and skin colour. Great scientists such as charles Darwin, Gregor Mendel and Francis Galton worked on heredity. All living things are made up of cells which contains nucleus that encloses the chromosome that contains the genes. The genes are the molecules which govern the characteristics transmitted from parents to children.

Dominant genes produce those traits which show or are made manifest in an individual and cause offspring's to resemble one parent rather than the other. A recessive gene is not manifested when the dominant gene is also present, but an individual can pass it on and it can appear in later generations.

The environment includes the food you eat, the diseases, around or their absence, the weather, the insects and other animals, facilities for health and other facilities. The environment interacts with heredity to determine how an inherited trait develops. A nuclear family includes a

couple with their children, whereas an extended family includes other blood relatives.

Questions

1. Heredity refers to the transmission of characteristics from _____ to _____?
2. Chromosome refers as the carriers of heredity because it contains _____?
3. Distinguish between dominant and recessive genes or traits using an example?
4. Using an example, explain how heredity interacts with environment?
5. Distinguish between nuclear family and extended family?

Period 2: Ante - Natal care, intra-Partum care, post-natal care, child care and protection of infant.

Ante-natal care is a specialized service given to a pregnant woman by a trained midwife or obstetrician. Intra-partum care refers to the specialized care given to a woman in labour and immediately after delivery. Post-natal care refers to the specialized care given to a mother and her baby in the first six weeks following delivery, weaning refers to the process of taking the baby off the breast or off an entirely milk food, and giving him semi-solid food supplemented with milk drinks.

The baby is protected from infection and diseases by ensuring cleanliness and giving immunizations. The process of weaning should begin from about the age of three months and is completed by about the age of nine or ten months. If a child is not weaned on to an adequate diet, he may develop malnutrition and then he will be weak and may not develop well.

Maintenance of cleanliness includes: keeping the child's surrounding clean; keeping his clothes clean. Bathing him daily-except when the weather is cold; and washing and sterilizing the baby's feeding utensils. Sterilizing means to make an object free of germs or micro-organisms.

Immunization of infants which begins at the age of three months is against the following diseases: tuberculosis, poliomyelitis, whooping cough, tetanus, measles, diphtheria and smallpox.

Questions

1. Explain the term ante-natal care; intra-partum care; and post-natal care?
2. State the importance of each of the services listed above?
3. Fill in the blank spaces in the sentence: weaning commences by_____ and is completed by _____ and it involves _____

4. Mention two major ways of protecting a baby from infection and disease. Give one example of each of the ways you have mentioned?

Week Two

Topics: Resources from plaints, resources from animals, cash crops, food crops and their preservation, adaptation of mouth parts for feeding, animal food and methods of feeding, how plants make their food.

Objectives:

By the end of the lesson, the students should be able to

1. List some farm products and describe how they can be preserved;
2. Enumerate other resources that we get from plant and animals;
3. State the uses of named resources from plants and animals;
4. Explain how the bodies of some plants and animals are adapted to feeding;
5. Explain the way plants make their food;
6. State how plants store their food.

Period 1: Resources from plants, resources from animals, cash crops and food crops, their preservation.

There are vegetables we grow in our garden for their leaves, fruits, stems and roots; thus we have four major

types of plant resources such as food crops, crops for textiles, wood crops, and medicinal plants.

1. Leafy vegetables, in this we eat either cooked or fresh as salads. They provide us with minerals (calcium and iron) and vitamins (particularly vitamin A and C) which our bodies need. Examples are lettuce, cabbage, Talinum, and other plants used for “leafy soups”.
2. Fruits-e.g. peppers, tomatoes, Okro, mangoes, bananas, pawpaw, dates, oranges, lemons, pineapples and guavas. They provide the body with mineral salts and vitamins.
3. Seeds-examples are beans, maize, millet, sorghum, rice, barley and wheat. They provide us with starch, fat and protein. We use barley for brewing beer, and wheat to make flour used in baking bread and cakes. We also use sorghum and maize to make some local drinks.
4. Underground crops include stem tubers or swollen stems such as yam, cocoyam, and Irish potato; root tubers such as cassava sweet potato, carrot, raddish; and bulbs like onions. They provide us mainly with starch.
5. Oil plant are oil palm, groundnut, cotton, coconut, and olive. Cooking oil is produced from these seeds or fruits.

We have crops for textiles, are used for making cloth, ropes, basket and dyes.

Wood crops are used for building and furniture, e.g. mahogany, ebony, camphor. The soft woods are used for making wood pulp and paper as well as for building. Also the leaves of some plants are used for roofs, fences and for making furniture. Plants provide us with firewood which is a source of energy.

Roots, the bark and leaves of plants are used for medicines. These include against many diseases like fever, to heal wound, to stop frequent stools; to cure indigestion.

Resources from animals include food, wool, fur, leather goods, items of furniture, and manure.

Cash crops are crops produced mainly for sale, particularly to people in other countries of the world. These include fibre crops, oil crops, wood crops, and some food crops.

Methods for preserving food materials are salting, drying, smoking, processing, refrigerating, bottling and canning. Preservation of food helps to prevent food wastage; makes food available all the year round, and keeps food prices down.

Questions

1. What types of plants and animals do your people use?

2. In what ways do people use such plants and animals?
3. List all the major types of resources from plants and animals?
4. How can the food got from the plants and animals be preserved?

Period 2: Adaptation of month parts for feeding, animal food and methods of feeding; how plants make their food.

All animals feeding on solid foods have teeth, with which they tear or grind their food before swallowing it. The number and arrangement of teeth is called the dentition of the animal. The muscles of the jaw and check, the tongue, and the lips are also connected with feeding. The dentition of an animal is designed to suit the kind of food, which the animal eats.

Animals can be divided into three groups according to the kind of food they eat. There are the herbivores (or plant eaters), the carnivores (or flesh eaters), and the omnivores (which will eat both flesh and plant food).

The mouthparts of animals are specially adapted to the kind of food they eat. Mammals that eat solid food have teeth. Teeth are of different types and numbers according to whether an animal eats grass or flesh or both. There are four types of teeth, namely the incisors, canine, premolar and the molar. The number of teeth that an

animal has, and their types can be represented by what is called dental formula.

Dental formula for adult man is:

$$j\frac{2}{2}C\frac{1}{1}P\frac{2}{2}m\frac{3}{3}$$

The dental formula for the milk teeth of a child is

$$j\frac{2}{2}C\frac{1}{1}\ p\frac{2}{2}m\frac{3}{3}$$

Carnivores e.g. cat dental formula is

$$j\frac{3}{3}C\frac{1}{1}P\frac{3}{2}M\frac{1}{1}$$

Herbivores e.g. cow dental formuler is:

$$j\frac{0}{3}C\frac{0}{1}P\frac{3}{3}m\frac{3}{3}$$

Insects feed by biting or sucking. Birds have no teeth but they grind up their food using small stones stored in their gizzards.

Plants provide the basic food for all animals, even carnivores; carnivores feed on other animals, which are themselves herbivores. Plants make their own food and also sufficient for other creatures. They do this by using the chemical reaction between carbon dioxide and water, which produces carbohydrate and oxygen. The carbohydrate produced finally is starch but sugar is formed first. This reaction takes place only in the light. The green colouring matter of plants, chlorophyll, is necessary for the absorption of the necessary energy. This process is called photosynthesis. Not only does it provide

food for the plant itself and for other creatures which feed on it but it removes unwanted carbon dioxide from the atmosphere and replace it with oxygen.

Plants also build up proteins, oils and fats. Plants also store their food in special places called storage organs. The plants store these foods in the leaf, the root, the stem, and the seeds. The plants we use for vegetables store a good deal of carbohydrate that is why we grow them.

The equation for photosynthetic reaction in plant is:

Carbon dioxide + water = carbohydrate + oxygen

$6C0_2 + 6H_20 \Rightarrow C6H_{12}06 + 60_2$.

The equation for respiration is:

$C_6H_{12}60_2 \Rightarrow 6C0_2 + 6\ H_{12}06$

Questions

1(a) What do you understand by dentition?

(b) Illustrate your answer with one example each from carnivore, herbivore and omnivore dental formula?

2. Give examples of the animals of carnivore, herbivore and omnivores?

3(a). Explain how plants make their food?

(b) Write a balance equation of photosynthesis?

4. In what form is food stored in plants? Name three parts of the plants in which food may be stored?

Week Three

Topics: Symbols of elements, chemical formulae, simple chemical equations, Atomic theory and structure, Acids, bases and salts; Alkali and importance of Acids, bases and salts.

Objectives:

By the end of the lesson the students should be able to:

1. Identify the chemical symbols of common elements;
2. Write the chemical formulae of some compounds;
3. Write simple chemical equations;
4. Describe the structure of the atom;
5. State the properties of acids, bases and salts.

Period 1: Symbols of elements, chemical formulae, simple Chemical equation, balanced equation.

An element is a substance which consists of only one kind of matter. An element cannot be separated into more than one type of substance. The element gold contains no other substance except gold. The same is true of the element copper. But when copper and oxygen are chemically combined, they form a new substance which is a compound. A compound is defined as a substance which contains two or more elements chemically combined.

A chemical symbol is an abbreviated form of the name of an element, which represents one atom of the element. Some chemical symbols are derived from the

Latin names of the element. A chemical formula is a representation of the composition of a compound using chemical symbol and subscripts. A chemical formual indicates the elements in a compound and the ratio of their atoms.

The formula of an ionic substance shows that the total charge on the positive ions balances the total charge on the negative ions. Hydrogen gas + oxygen gas => water

reactants product

Using chemical equation instead of a word equation.

$H_2(g) + O_2(g) => H_20$

To balance the above chemical equation will be.

$2H_2(g) => 2H_20$

A chemical equation is a condensed statement of facts about a chemical reaction. Chemical reactions involve reactants and products. Reactants are substances that exist before a reaction takes place. Products are the substances that are formed as a results of the chemical reaction.

The steps in writing a balanced chemical equation are:

(a) Write a word equation

(b) Write an unbalanced formula equation.

(c) Write coefficients to balance the formula equation.

Questions

1. Write the chemical symbols of the following elements: (a) copper (b) iron (c) manganese (d) potassium (e) silver (f) Neon.
2. Write the chemical formulae for the following: (a) sodium iodide (b) calcium oxide (c) aluminum oxide (d) potassium nitride (e) sodium hydroxide.
3. Write and balance each of the following equations:

(a) When calcium trioxocarbonate (iv) is heated, it decomposes and forms calcium oxide and carbon dioxide.

(b) Tin reacts with oxygen to form tin oxide.

(c) Sodium reacts with chlorine gas to produce sodium chloride.

(d) Cl_2 + NaBr => Br_2 + Nacl

(e) Na + H_20 => NaoH + H2

(f) Cu + H_2S0_4 => $CuSO_4$ + H_20 + $S0_2$.

Period 2:

Atomic theory and atomic structure. Atomic model.

In about 1803, a brilliant English chemist, John Dalton, put forward the atomic theory. Dalton was like many of his colleagues, limited by not having very modern apparatus to carry out his work. However, he put together some statements, which are now called Dalton's Atomic theory are:

1. All elements are composed of atoms, which are indivisible and indestructible particles.
2. All atoms of the same element are exactly alike; in particular, they have the same mass.
3. Atoms of different elements are different; in particular, they have different masses.
4. Compounds are formed by the joining of atoms of two or more elements in a definite whole-number ratio.

At the time Dalton published his atomic theory, it helped to explain a number of observations, especially about the way in which elements combined together to form compounds. It is now known that the atom is made up of a number of different particles. There are three fundamental units: the electron, the proton, and the neutron.

Ernest Rutherford in 1909 carried out experiments which showed that most of the atom is empty space. Most of mass was concentrated in a small dense central part called the nucleus. The electrons are at a comparatively great distance from the centre of the atom and they travel rapidly and continuously in orbits around its centre. It is found that electron carries a negative electric change.

The proton is a positively charged particle found in the nucleus. Although the positive charge on the proton has the same magnitude as the negative charge on the

electron, the mass of the proton is about 1800 times larger than that of the electron.

The number of protons in the nucleus of an atom is called its atomic number. The atomic number also tells the number of electrons that are normally present in an atom. The sum of the protons and neutrons in the nucleus of an atom is called the mass number.

Retherfold's model of the atom supposed that the atom has a small, dense, positively charged nucleus surrounded by relatively "empty" space the electrons continuously orbit the nucleus at a comparatively great distance from it.

There are three types of hydrogen atoms, all of which have one electron, with one proton in the nucleus, but they differ in mass. The most common type is called protium. Protium has a nucleus consisting of a single particle: that particle is a proton. It therefore has one proton and no neutron. The second kind of hydrogen atom is called deuterium. This has twice the mass of protium. This is because it has one proton and one neutron.

The third kind of hydrogen is called tritium; which has a nucleus consisting of one proton and two neutrons. The particles of protons and neutrons that make up the nucleus are called nucleons.

Questions

1(a) briefly describe the four basic ideas of Dalton's atomic theory?

(b) What modification's have been made to Dalton's theory?

2. What are nucleons? What other fundamental particle is present in the atom?

3. How does the proton compare with the electron in terms of (a) electrical charge (b) mass?

4. What do you understand by the terms (a) Mass number (b) atomic number?

5. Draw a simple model of a helium atom with two electrons, two protons, and two neutrons.

Period 3:

Definitions of Acid, Base and salt; the properties of Acid, base, Akalis, and importance of acids, bases and salt.

Acid is a substance that produces hydrogen ions (H^+) as the only positive ion when the acid is mixed with water. Acids react with calcium trioxocarbonate (iv) to produce a colourless gas which is called carbon (iv) oxide. Acids also react with some metals like magnesium and zinc to produce a colourless gas which is called hydrogen. Acid generally have a sour taste. Acids turn blue litmus paper to red. Concentrated acids are corrosive.

According to the definition of Arrhenius, a base is any hydroxide that dissolves in water to yield hydroxide (OH^-) Ions as the only negative ion.

e.g. KOH => $K^+ + OH^-$

Other properties of bases are:

1. Bases have a slippery or soapy feel
2. Bases turn red litmus paper blue
3. Concentrated solutions of bases are corrosive.

The reaction of a base with an acid is very important. Bases neutralize acids. The reaction whereby a base reacts with an acid to produce a salt and water only is called a **neutralization** reaction. E.g. the reaction between sodium hydroxide (NaOH) and hydrochloric acid (HCL), the products are sodium chloride (NaCl) and water (H_20). The Sodium hydroxide ion. Sodium chloride, NaCl, is a salt composed of the sodium ion Na^+ and the chloride ion, Cl^-:

The Importance of Acids, Bases and Salts.

Acids play important roles in the life processes that go on inside our bodies. Acids are present in some of the food item we eat, e.g. fruits. Vitamin C which helps to build up our bodies is an acid. Acids are used in many industrial processes especially in the manufacture of fertilizers, dyes and explosives:

Bases are commonly used in the home either as a cleaning agent (ammonia water) or as a laxative (milk of

magnesia). Bases are used in industrially in the manufacture of soaps, rayon, and paper.

Salts are useful additives to our food, e.g. sodium chloride. Many of the chemicals used in laboratories are salts.

Litmus paper is an indicator that can tell us if a given solution contains either an acid or an alkali. If we have two acidic solutions or two basic solutions, our litmus paper indicator can only tell us whether they are acidic or basic. But it cannot tell us which of the two acid solutions contains a greater concentration of H_30^+ ion. Similarly, our litmus indicator cannot tell us which of the two basic solutions contains a higher concentration of OH^- ions. This is a shortcoming of the use of litmus paper as an indicator.

However, it has been possible to obtain an indicator, which not only tell us whether a solution is acidic, but can also distinguish differences in the acid content of the acidic solutions. This indicator, which is called a universal indicator, changes colour not just to red and blue but into many other colours. These various colours of the universal indicator correspond to certain degrees of acidity.

A scale which shows the degree of acidity is called a pH scale. In effect, pH simply refers to the concentration of H^+ ions in any given solution. The pH scale ranges from 0-14. A solution with a low pH such as 2, is more acidic than a solution with 6. A solution of 7 is neutral; one with

a pH less than this is acidic one with a pH greater than 7 is alkaline.

Water, has a pH of 7. Thus a solution with a pH of 8 contains less $0H^-$ ion that a solution with pH of 14.

To use a universal indicator to test a given solution, you note the colour of the indicator and compare it with those on the pH scale. Thus, you can find the pH value of the solution.

Questions

1. Distinguish between acids, bases and salts.
2. Why are hydronium ions formed when acids are dissolved in water? Write a balanced equation.
3. How are acids, bases and salts useful to us? Give specific examples of their use.
4. What do you understand by the term neutralization?
5. What do you understand by the term pH value?
6. Would you feel confident drinking a solution with a pH value of 7? Give your reasons.

Week Four

Topics: Characteristic of metals and non-metals, differences between metals and non-metals, reactivity of metals and non-metals, extraction of iron and manufacture of steel. Energy conversions; changing potential energy to kinetic energy, changing energy from one form to another. Energy transfer,

conduction, convection, Radiation, Gravitational pull and weight, weightlessness, space travel.

Objectives:

By the and of the lesson, the students should be able to:

1. Distinguish between metals and non-metals,
2. Discuss simple processes for extracting some metals;
3. Explain the conversion of energy from one form to another.
4. Discuss how energy is transferred from one place to another;
5. Explain why bodies become weightless in space.

Period 1

Characteristics of metals and non-metals, differences between metals and non-metals, Reactivity of metals and non-metals, extraction of iron, and manufacture of steel.

Metals include zinc, aluminum, iron, and cooper while the non-metals include oxygen, carbon, nitrogen, sulphur, phosphorus, chlorine. Metals and non-metals vary in their reactivity. The arrangement of metals and non-metals in their order of reactivity is referred to as **activity series.** Metals combine with some non-metals to form compounds. The further apart two elements are in the activity series, the greater the possibility that they will form stable compounds. For example, magnesium burns

vigorously in oxygen to form magnesium oxide, which is very stable; while chlorine and oxygen, which are very close to each other in the series, combine to form chlorine dioxide which is very unstable compound.

The table below summarizes the physical properties of metals and non metals.

S/No	**Non-Metals**	**Non-Metals**
1	They have metallic lustre, i.e. they are shiny and can be polished.	They have no metallic luster. They are not shiny and cannot be polished.
2	They, are good conductors of heat and electricity.	They are non-conductors of heat and electricity-the only exception is certain forms of carbon which are conductors of electricity. Because non-metals, are non-conductors they may be used as insulators.
3	They are malleable i.e. they can be beaten or hammered into thin sheets.	They are very brittle and cannot be hammered.
4	They are ductile, i.e. the can be drawn into wires.	They cannot be drawn into wire.
5	They are generally very strong and hard.	They are generally soft.

Chemically metals behave differently from non-metals and can be distinguished from each other on the basis of their reactions. This is because elements which burn in oxygen giving basic oxides are metals. It is important to note, however, that not all metals can burn directly in oxygen. The oxides of such metals can be prepared indirectly. The oxides of non-metals are acidic.

Metals are arranged in such an order that the metal which is higher up in the series can displace any metal

below it from a solution of it salts. This arrangement of metals, from the most reactive to the least reactive metal, is referred to as the activity series. The following is the order of reactivity of metals.

Potassium
Sodium
Calcium
Aluminum
Zinc
Iron
Lead
Hydrogen
Copper
Mercury
Silver
Gold.

For non-metals, it is usually to arrange them from the least reactive to the most reactive as follows:

Carbon
Nitrogen
Phosphorus
Sulphur
Oxygen
Chlorine
Fluorine.

This means that fluorine is the most reactive of the non-metals while, carbon is the least reactive in the above series.

Metals are usually electropositive and non-metals are electronegative. By electropositive, is meant the ease with which atoms of metals give off the electrons in their outermost shell to attain the stable arrangement of eight or two electrons, while electro negativity refers to the ease with which non-metal atoms accept electrons. Just as some metals are more electropositive than others, so also are some non-metals more electronegative than others.

Iron can be extracted from its ore in a blast furnace. Steel is an alloy of iron and carbon containing between 0.15 percent to 1.5 percent of carbon. Steel can be manufactured by the Bessemer process or by Direct Reduction process of iron ore. The hardness of steel can be varied by

(a) Varying the percentage of its carbon content;

(b) Tempering

(c) Alloying the steel with other metal.

Tin, like iron, is extracted by reducing the tin ore with coke or anthracite in a reverberatory furnace. Tin is used in electroplating and making alloys such as solder and type metal.

Questions:

1. State the physical differences between a metal and a non-metal.
2. State one chemical difference between a metal and a non-metal. You are provided with the following substances: an iron bar, sulphur, silicon and magnesium.
3. Describe a simple experiment to help you sort out these substances into metals and non-metals.
4. Briefly describe the method of extracting iron or tin from its ore.
5. Arrange the following metals in their increasing order of reactivity: sodium, iron, aluminimum, pofassium, silver, lead, zinc, copper, hydrogen.
6. Explain briefly the integrated direct reduction method of manufacturing steel.
7. Name two main alloys each of steel and tin and state their uses?

Period 2:

Energy conversion, changing potential energy to kinetic energy, changing energy from one form to another.

Energy is required to do work. Work is done when a force moves through a distance and it is measured by the force multiplied by the distance through which the force moves. A body that has energy can do work. The energy

may be imparted to and stored in a body by doing work on that body. Stored energy is called potential energy. We have come across chemical energy, energy of movement (i.e. kinetic energy or mechanical energy), electrical energy, light, heat, and sound. These forms can be converted into one another.

Heat energy can be converted to light energy as when we heat any solid and it becomes red hot, it glows. Firewood and metals often glow when they are heated.

Conversion of electrical energy to mechanical to sound energy could be obtained, when you connect an electric bell with a battery through a switch and press the switch. Energy conversion could be seen in appliances such as bicycle, pressing iron, Radio, television and telephone. Also electric motor could also convert the electric energy into mechanical energy.

Questions

1. Describe the energy changes that occur when electric pressing iron is used to press clothes?
2. How can we make a falling body to work on another body? What energy changes occur in such a situation?
3. Name two appliances in the home. Describe the energy conversions in each of them?

Period 3:

Energy transfer, conduction, convection, Radiation, gravitational pull and weight, weightlessness, space travel.

Heat can travel from one place to another. The method of heat transfer from the sun through space is called **Radiation.** Other ways of transferring heat are condition and convection. In radiation, the heat transfer does not involve any material between the source of the heat and the receiver. The heat is transferred by means of waves. The transfer of heat by the movement of liquid molecules is called **convection.** The transfer of heat energy through a substance without the movement of the particles in a rod is called **conduction.**

Metals are usually good conductors, though some are better than others; non-metals, such as glass, wood, and air are bad conductors. We found the same applies for the conduction of electricity. Some substances (mostly metals) conduct electricity; other (mostly non-metals) do not conduct electricity. The latter are called insulators. All metals do not conduct electricity equally well. They all oppose the current to a certain degree. The thinner the wire and the longer the wire the more it opposes the current. Opposition to current is called resistance.

For an electric current to be maintained, there must be a complete circuit. A switch is used to make or break a

circuit. Current and potential differences are measured with an ammeter and a voltmeter respectively.

It is very dangerous to carry out experiments with the main electricity. Electricity is transmitted to our homes by means of cable from the power station. Circuits are so arranged that when one appliance is switched on or off the others are not affected. In a series circuit, the conductor are placed one after the other. The same current passes through all of them. If one of them is switched off, then they all stop functioning.

In a parallel circuit, the current divides and passes through each conductor separately. If one is switched off, it does not affect the others. This is the type of circuit used in houses. A fuse is a safety device. If too large a current is taken, the fuse melts and breaks the circuit, thus stopping the cables from getting over heated and causing a fire.

A sound is produced by bodies vibrating. It travels in waves, but must have a medium to travel through, such as air. This is unlike heat or light, which can travel through a vacuum. Sound travels at about 1150 kilometres an hour; light travels at about 300,000 kilometres a second. When sound is reflected from an obstacle, it returns as an echo. A sound of regular or uniform vibration is called a note or musical note and music is a combination of such sounds. A sound of irregular or varying vibration is called noise.

When pleasant sounds are produced, we have music. The instrument used in producing such sound are called musical instruments, and each produces a distinct sound, hence we call tell the instrument from the sound it produces without necessarily seeing the instrument.

Gravitational force is a '"force field" which acts on other bodies across a distance without making contact. Gravity is the force with which the Earth attracts objects towards its centre.

Weightlessness is a feeling which a person or an object experiences when the weight, that is, the gravitational attraction, is just equal to the force necessary to keep the body moving freely in space.

Many artificial satellites have been launched into space and some of them have carried astronauts and instruments such as cameras, thermometers, television sets and radio equipment. It requires enormous energy to launch a spaceship into orbit. Such energy can be supplied by rockets which work on the principle of jet propulsion.

Questions

1. Group these substances into good and bad conductors: copper, water, sand, mercury, wood, iron, glass, carbon?

2. State three ways by which heat can be transferred from one point to another?
3. State the use of fuse in an electric circuit?
4. Describe the production and transfer of sound energy. State two properties of sound waves?
5. Distinguish between noise and music. Give three examples of musical instruments?
6. The weight of an object may change even though its mass remains constant. Explain.
7. What is weightlessness? Why do objects in a spaceship become weightless? What are the problems associated with this experience in space travel?

Week Five

Topics: Concept of work, mechanical advantage, efficiency, pollution, air and water pollution, treatment of sewage, oil spillage, erosion and flooding, wind and water erosion, control of flood. Relative humidity, atmospheric pressure, clouds and storms.

Objectives:

By the end of the lesson, the students should be able to:

1. Recognize that work is done only if a force causes a displacement;
2. Calculate the work done when a given force moves an object through a known distance in the direction of the force;

3. Recognize that energy is required in doing work;
4. State the energy changes that occur when work is done.
5. Explain certain problems that are related to the pollution of the air and water in Nigeria.
6. Explain the possible effects of oil spillage on Nigerian environment;
7. Describe the methods of prevention and control of erosion and flooding.

Period 1

Concept of work, mechanical advantage, efficiency, pollution, the air and water pollution, treatment of sewage and oil spillage.

Work done is a measure of energy and both work and energy have the same unit, the joule (J). Work done is the force applied and the distance moved in the direction of the force. Energy changes occur when work is done. Energy stored is potential energy, while energy due to motion is kinetic energy. A part from human beings doing work, there are non-human means of doing work, examples are the hurricane or a tornado, which can move very large objects. A primary purpose of using a machine is to obtain a mechanical advantage, that is where the ratio $\frac{load}{effort} > 1.$

The efficiency of a machine is

$$\frac{work\,output}{work\,input} x \frac{100}{1}$$

Percent (it is $\frac{force\ ratio}{relocity\ ratio} x100\,percent$)

and because of friction, no machine can be perfectly efficient.

When substances are introduced into air and water which make them harmful to life, they are said to be polluted. Such harmful substances are called pollutants. Air pollutants can be solids, liquids or gases. The number of solid particles that can be found suspended in the air depends upon many things; such as the season of the year, the locality or the environment. The gaseous pollutants could be carbon dioxide, carbon monoxide or sulphur (iv) oxide. Solid pollutants include smoke and dust, liquid pollutants include acid rain.

Sewage is treated for two reasons. The harmful micro-organisms must be killed and the amount of organic materials returned to the water must be reduced. There are three kinds of treatment that can occur in a sewage treatment facility. Primary sewage treatment removes about half of the suspended solids and bacteria in the sewage. Secondary sewage treatment removes an additional 35-40 percent (or a total of 85-90 percent) of the suspended solids in the water. Chlorine can be added, after primary or secondary treatment, to kill the harmful

microorganisms in the water. In tertiary sewage treatment, the wastewater is treated even more to produce cleaner water that will be emptied into the waterways. There are very few cities in the world that use tertiary sewage treatment.

Oil has brought much wealth to Nigeria that can be used to facilitate development. One side effect of the production of oil is the possible pollution of water. Additional pollutants enter the water through fallouts from gas flares, used lubricating oils, oil tank washing, emptying of water used to balance empty oil tankers when they are moving in the ocean, and leakages from marine vessels and outboard engines. The coast of Nigeria is one of the endangered environments in the world due to oil spillage. The biological communities mostly affected by these oil spillages are the mangrove swamps. These are found near the coast where the fresh and the salt water mix.

Questions

1. A boy standing on the top of a building throws a stone to light an object on the ground. State the energy change that occur in this event?
2. Explain the terms potential energy, kinetic energy, mechanical advantage, velocity ratio and efficiency of a machine.

3. A man of mass of 90 kg is moving at a constant velocity. He has kinetic energy of 2205 J. Calculate his velocity.
4. A wheel and axle is used to raise a bag of garri of mass 50.4kg to a height of 5m. If the efficiency of the machine is 62.5 percent and the radii of the wheel and axle are 30cm and 5cm respectively, calculate:

(a) The work output of the machine;

(b) The expression for the work input;

(c) The effort applied.

5. How is primary sewage treatment different from secondary sewage treatment?
6. What are the sources of oil spillage in Nigeria?

Period 2

Erosion and flooding, wind and water erosion, control of flood, relative humidity, atmospheric pressure, clouds and storms.

Human population is growing exponentially. Food supply limits population growth. Soil in Nigeria is becoming infertile due to increase farming caused by a growing population. Erosion is the wearing away of rock and soil; it is caused by the action of wind and water. The breaking down of the Earth's surface is called weathering. Forests planted to help prevent wind erosion are therefore called windbreaks. Forests protect land from erosion and

flooding. Agroforestry is an experimental approach to the use of land in tropical areas in which food crops and trees are grown on the same piece of land.

Floods occur naturally in the flood plain of a river. There are many factors that interact and cause a flood to occur, such as, the amount of water that runs off the land; the amount of rainfall; the temperature; the type and condition of the soil; the amount and types of vegetation and the amount of water the valley around the river can store. Engineers do build walls and dams that can hold back much of the water that can cause floods.

Floods can be controlled or we can learn to live with them; decisions about what to do depend upon scientific, social, political and economic factors. Basically, a government can do three things. It can try to change the flood; it can leave the flood and perhaps help the victims; or it can change the use of the land on which the flood will occur.

The weather in any place is affected by the temperature of the atmosphere, atmospheric pressure, winds, humidity, rainfall and sunshine. Meteorology is the scientific study of the atmosphere and the changes that take place in its weather. A psychrometer is an instrument used to measure the amount of water vapour present in the air.

Relative humidity is the ratio of the amount of moisture in the air compared with the amount of moisture that the air could hold at that temperature if it were completely saturated. A barometer is an instrument used for measuring the pressure of the atmosphere. Falling barometric readings indicate bad weather while rising barometric readings indicate fair weather.

Isobar is a line on a chart, which joins all places having the same barometric pressure. **Isotherm** is a line on a chart, which joins all places having the same temperature. Isohyet is a line on a chart, which joins all places having the some amount of rainfall. Fog is a cloudlike mass of minute water droplets found near the surface of the earth. Visibility is the degree or distance to which things can be seen under certain conditions of the weather.

What causes thunderstorms can be said that the air above the surface of the Earth is always moving and as it does so all kinds of particles in it can rub against each other and become electrically charged. In this way, clouds which are made up of tiny drops of water can become very strongly charged.

When clouds become charged with electricity, a spark may pass from the cloud to the earth or to a nearby cloud. This spark is lightning. This lightning is followed a few seconds later by thunder. This is caused by the heating of

the air by the spark as it passes through. The heat makes the air expand. The air quickly cools again and goes back to its original volume, so the air moves very violently. This causes the noise.

Questions

1. What is exponential growth?
2. Why are trees being planted in the northern part of Nigeria?
3. How is agroforestry like traditional farming?
4. Give an example of an agricultural practice that increases the incidence of erosion?
5. What is a flood plain?
6. State the factors that affect the weather of a place?
7. What is relative humidity, and state the instrument use in measuring pressure of the atmosphere?
8. Explain the following terms: Isobar, isotherm, Isohyet, fog, and visibility?

APPENDIX V

LESSON PLAN FOR CONTROL GROUP

The instructional technique follows the pattern described below

Topic: The topic to be taught in the lesson will be written on the chalk board.

Objectives: These would be stated in behavioural terms.

Introduction: The teacher presented a brief review of the lesson, which relates, to the student's previous knowledge and writes out the concepts to be taught on the chalkboard.

Presentation: The teacher narrates the content of the lesson in short steps, giving the knowledge, facts, and information to be learnt and ask questions to conclude the lesson.

Students' Activity: During the lesson, the students listen, write down the points and ask questions for clarification.